S. HRG. 104-186

HEARING ON THE NASA SPACE SHUTTLE AND THE REUSABLE LAUNCH VEHICLE PROGRAMS

HEARING

BEFORE THE

SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE

OF THE

COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION UNITED STATES SENATE

ONE HUNDRED FOURTH CONGRESS

FIRST SESSION

MAY 16, 1995

Printed for the use of the Committee on Commerce, Science, and Transportation

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HEARING ON THE NASA SPACE SHUTTLE AND THE REUSABLE LAUNCH VEHICLE PROGRAMS

TUESDAY, MAY 16, 1995

U.S. SENATE,
SUBCOMMITTEE ON SCIENCE, TECHNOLOGY, AND SPACE,
COMMITTEE ON COMMERCE, SCIENCE, AND TRANSPORTATION,
Washington, DC.

The subcommittee met, pursuant to notice, at 9:30 a.m., in room SR–253, Russell Senate Office Building, Hon. Conrad Burns (chairman of the subcommittee) presiding.

Staff members assigned to this hearing: Louis C. Whitsett, staff counsel, and Timothy B. Kyger, professional staff member; and Patrick H. Windham, minority senior professional staff.

OPENING STATEMENT OF SENATOR BURNS

Senator BURNS. It is 9:30, and we have a vote this morning, although that has not been determined yet.

We appreciate you coming this morning. The Science Subcommittee will examine the current Space Shuttle program and NASA's effort to develop technologies and reduce the technical risk for replacement for the Shuttle.

For all the criticism leveled against it, our Shuttle remains the world's most reliable launch vehicle. It is the foundation of our human exploration program and NASA's research into the life and micro-gravity sciences.

Over the next decade, the Shuttle will be more important than ever. Between now and fiscal year 1997, NASA will fly seven Shuttle missions to the Russian Space Station Mir to prepare us for the enormous task of constructing the International Space Station.

After the Shuttle/Mir activities, NASA will fly the Shuttle another 27 times to transport hardware and supplies to the station during its assembly phase, which will end in the year 2002. It seems like that year has a habit of popping up in all of our colloquies now.

However, as demands of the Shuttle are increasing, the budget for its operation is shrinking. Since 1992, the budget for the Shuttle has gone from $4 billion to $3.1 billion. During that period, NASA cut its Shuttle-related civil service and contractor personnel by 6,000 people while maintaining its normal flight rate of 7 per year.

I might add a note here that it is, in my opinion, a NASA success story. The men and women of NASA have cut *substantial* amounts

of money and personnel from the Shuttle program, and they have done it successfully.

But under NASA's 5-year plan, this budget trend continues. The current plan reduces the human space flight budget, which funds the Shuttle and Space Station, from $5.5 billion in fiscal year 1995 to $4.9 billion in fiscal year 2000.

Also, $800 million of those cuts are unresolved reductions that NASA does not yet know how it will accomplish. So many people inside and outside NASA have openly questioned whether this budget pressure will negatively impact safety.

In fact, last year it was reported that Robert Crippen, the former director of the Kennedy Space Center, and Jeremiah Pearson, the former head of the Shuttle program, both resigned over fears that the emphasis on the budget cutting might compromise safety.

It is our obligation as a congressional oversight committee to make sure that the Shuttle is safe. Budget cutting can never take precedent over the lives of our astronauts and people in the space program.

The 1986 Challenger incident is a lasting reminder of the importance of that principle. To its credit, NASA has commissioned internal and external reviews to determine how much cutting and restructuring the Shuttle program can withstand without raising serious safety concerns.

Hopefully, the subcommittee will have a chance to explore the safety issue in depth this morning.

As great as the Shuttle has been, all agree it will soon start to outlive its usefulness. The Shuttle operates on 1970's technologies, less sophisticated than our average commercial airplane. Moreover, the Shuttle cost over $400 million per launch to fly.

The challenge before NASA is to make the current Shuttle more cost effective while also planning for a post–Shuttle future. With regard to the current Shuttle program, we look forward to discussing ways in which it can be made less costly, to make it more efficient and more reliable.

In March, an independent panel headed by Chris Kraft, the former director of the Johnson Space Center, recommended that the Shuttle space operations be placed under the control of one prime contractor with NASA's role reduced to top level oversight.

Industry has estimated that this one change by itself could reduce the program costs by 10 to 20 percent, and that is a move that we could quickly implement. The panel further recommended that NASA start the transition toward privatization of the Shuttle program, which could deliver even greater cost efficiencies.

Industry would operate the Shuttle on a commercial basis for NASA and other government and private sector customers.

While the privatization model for the Shuttle seems attractive as a general concept, it cannot be seriously evaluated until we focus on the details on how it would be carried out.

Before we go too far down this road of privatization, we need to ask questions like: Who would own the Shuttle? Who would own the launch facilities? And who would bear the legal responsibility for Shuttle mishaps? And what types of payloads would be carried? And what types of customers could be accepted?

We hope to explore maybe some of those answers, but if you listen to those questions, they are very, very broad, and I do not think we could do it in a day or even 2 days of hearings here to get all the answers.

Finally, we will examine NASA's program to develop the technologies to enable the new launch system that might eventually replace the Shuttle, their X–33 program. There is little question that we must start considering life after Shuttle.

However, NASA's budget is shrinking, not expanding, and it is not clear just how NASA will pay for these efforts, particularly the X–33 program.

If NASA decides next year to go forward with building an X–33 test vehicle, the development and operational costs could total around $650 million by the end of the decade.

Even with cost sharing by industry, many have questioned how NASA will be able to fund another program while cutting $5 billion from its budget over the next 5 years, maintaining other billion dollar programs like the Space Station, and funding new starts in science and astronomy.

That having been said, we want to stay competitive in the commercial launch market. We must develop strategies for bringing our launch systems into the 21st century, as other spacefaring nations now are doing. The U.S. cannot afford to be left behind.

And I would also, even though my words said how NASA would do that, I speak as if NASA is a separate arm from this government or from the American people. I do not think that, because I think the American people and NASA make a great partnership.

I would also like to take the opportunity to extend a welcome to our colleague from the other body, Chairman Rohrabacher, who is with us this morning.

We also welcome a distinguished panel of witnesses from the NASA industry and academia to this subcommittee. We will have a number of questions for you today.

It is sort of a format where we will start probably a dialog around the table, where we will address and encourage that dialog so that we understand each other on the challenges that are ahead for the space program. And I thank you for appearing before this committee today.

Chairman Rohrabacher, if you will come forward, please.

It is an honor for us to have you over here this morning. We will take your statement.

You can either do your own statement, or you can give it as you like. But welcome and thanks for doing the work on the House side over there. We appreciate your work very much.

[Prepared statement of Senator Burns]

PREPARED STATEMENT OF SENATOR BURNS

STATMENT OF SENTOR BURNS

This hearing will now come to order. Today, our Science Subcommittee will examine the current Space Shuttle program and the NASA efforts to develop the technologies and reduce the technical risk for a replacement for the Shuttle. For all the criticism leveled against it, our Shuttle remains the world's most reliable launch vehicle. It is the foundation of our human exploration program and NASA's research in the life and microgravity sciences. Over the next decade, the Shuttle will be more important than ever. Between now and FY97, NASA will fly seven Shuttle missions

to the Russian space station Mir to prepare us for the enormous task of constructing the International Space Station. After the Shuttle-Mir activities, NASA will fly the Shuttle another 27 times to transport hardware and supplies to the Station during its assembly phase, which will end in the year 2002.

However, as the demands on the Shuttle are increasing, the budget for its operations is shrinking. Since 1992, the budget for the Shuttle has gone from $4 billion to $3.1 billion. During that period, NASA cut its Shuttle-related civil service and contractor personnel by 6000 people, while maintaining its normal flight rate of seven per year. I might add note here that this is, in my opinion, a NASA *success* story—the men and women of NASA have cut *substantial* amounts of money and personal from the Shuttle program, and successfully! But under NASA's five-year plan, this budget trend continues. The current plan reduces the Human Space Flight budget (which funds the Shuttle and Space Station) from $5.5 billion in FY95 to $4.9 billion in FY2000. Almost $800 million of those cuts are "unresolved reductions" that NASA does not yet know how it will accomplish.

Many people inside and outside of NASA have openly questioned whether this budget pressure will negatively impact safety. In fact, last year, it was reported that Robert Crippen, the former director of the Kennedy Space Center, and Jeremiah Pearson, the former head of the Shuttle program, both resigned over their fears that the emphasis on budget cutting might compromise safety. It is our obligation as a Congressional oversight committee to make sure that the Shuttle is safe. *Budget cutting can never take precedence over the lives of our astronauts.* The 1986 Challenger incident is a lasting reminder of the importance of that principle. To its credit, NASA has commissioned internal and external reviews to determine how much cutting and restructuring the Shuttle program can withstand without raising safety concerns. Hopefully, the Subcommittee will have the chance to explore the safety issue in depth this morning.

As great as the Shuttle has been, all agree that it will soon start to outlive its usefulness. The Shuttle operates on 1970s technology less sophisticated than that of your average commercial airplane. Moreover, the Shuttle costs over $400 million per launch to fly. The challenge before NASA is to make the current Shuttle more cost-effective, while also planning for a post-Shuttle future.

With regard to the current Shuttle program, we look forward to discussing ways in which it can be made less costly, more efficient, and more reliable. In March, an independent panel headed by Chris Kraft, the former director of the Johnson Space Center, recommended that Shuttle operations be placed under the control of one prime contractor, with NASA's role reduced to top-level oversight. Industry has estimated that this one change by itself could reduce program costs by *10 to 20 percent* and that the move could be quickly implemented. The panel further recommended that NASA start a transition towards a "privatized" Shuttle program, which could deliver even greater cost-efficiencies. Industry would operate the Shuttle on a commercial basis for NASA and other government and private sector customers. While the privatization model for the Shuttle seems attractive as a *general concept,* it cannot be seriously evaluated until we focus on the *details* of how it would be carried out. Before we go too far down this road to privatization, we need to ask questions like: who would own the Shuttle; who would own the launch facilities; who would bear the legal responsibility for Shuttle mishaps; what types of payloads could be carried; and what types of customers could be accepted? We hope to explore some possible answers to these policy questions at today's hearing.

Finally, we will examine NASA's program to develop the technology to enable a new launch system that might eventually replace the Shuttle—their X-33 program. There is little question that we must start considering "life after the Shuttle." However, NASA's budget is shrinking, not expanding, and it is not clear just how NASA would pay for these efforts, particularly the X-33 program. If NASA decides next year to go forward with building an X-33 test vehicle, development and operational costs could total $650 million by the end of the decade. Even with cost sharing by industry, many have questioned how NASA will be able to fund another program, while cutting $5 billion from its budget over the next five years, maintaining other billion-dollar programs like Space Station, and funding new starts in science and astronomy. That having been said, if we want to stay competitive in the commercial launch market, we must develop strategies for bringing our launch systems into the 21st Century as other spacefaring nations are now doing. The U.S. cannot afford to be left behind.

I would also like to take this opportunity to extend a welcome to our colleague from the other body, Chairman Rohrabacher, and to also welcome our distinguished panel of witnesses from NASA, industry, and academia to the Subcommittee. We will have a number of questions for all of you; however, the Subcommittee is using the "one panel" format today to encourage dialogue among the witnesses here today.

So if you have something to contribute during our questioning of the panel, please do not hesitate to share your views with the Subcommittee and fellow witnesses. Thank you again for appearing before the Subcommittee.

STATEMENT OF SENATOR HOLLINGS

PREPARED STATEMENT OF SENATOR HOLLINGS

Today's hearing on space launch programs at the National Aeronautics and Space Administration (NASA) comes at a critical point in the history of the space program. A combination of severe budget pressures and changing national needs now forces us to look very carefully at NASA's budget priorities.

I have long been a supporter of the space shuttle and of the men and women who fly and service it. If we are to continue the shuttle program, however, we must ensure that it is adequately funded at the level necessary to maintain safety. Safety must remain our priority.

In the current budget environment, maintaining an adequate shuttle program may very well require cutting other NASA programs. NASA will not be exempted from budget reductions, and we therefore face hard choices. I hope that in today's hearing and in other discussions in the weeks and months ahead, the Committee will take a hard-headed look at what we can and cannot afford in this new era.

STATEMENT OF SENATOR PRESSLER

PREPARED STATEMENT OF SENATOR PRESSLER

Mr. Chairman, I want to thank you for holding this oversight hearing on NASA's Space Shuttle and Reusable Launch Vehicle programs. The Shuttle remains the world's most reliable launch vehicle, but its technology has become outmoded and it is extremely expensive to operate. Clearly, it is time for a change. As a result, NASA faces a dilemma similar to that of the consumer who must decide when to stop putting money into the old reliable clunker and purchase a shiny new—and expensive—automobile. That kind of decision is never easy.

Given today's budget environment, NASA may not have any choice but to maintain the old reliable Shuttle until we can afford a new vehicle. NASA is looking at cutting $5 billion from its budget over the next five years. In addition, Congress is struggling to craft legislation to reduce the federal deficit and balance the budget. To do this, Congress is actively considering cutting, not just programs, *but entire Cabinet-level agencies.* Accordingly, the best we can do may be to make the current Shuttle as cost-effective and as safe as possible.

Over the next decade, America will rely on the Shuttle as never before as it begins construction on the Space Station. Between 1997 and the year 2000, the Shuttle is scheduled to fly 27 missions to deliver parts and supplies to the Space Station. At the same time, the Shuttle program is facing intense pressure to cut costs. While we here in Congress applaud cost cutting, safety must always be first. As NASA reduces personnel to reduce costs, it must guard against taking shortcuts that would put our astronaut crews at risk. I know Dr. Wayne Littles, who will testify today, headed an internal NASA study that looked into this issue and I will look forward to hearing his views on this matter.

I understand privatizing the Shuttle may provide one of the safest ways to cut Shuttle costs. The aerospace industry estimates that merely placing the Shuttle program under the management of one prime contractor, with a reduced oversight role for NASA, would cut costs by *10 to 20 percent. Full* privatization could yield even greater benefits. It is in the national interest for NASA to work with industry to develop reasonable options for privatization that Congress might consider.

We recognize that, over the next decade, the Shuttle will be concentrating on visits to the Russian space station *Mir* and missions to construct the International Space Station. Nevertheless, we must not lose sight of other, perhaps more relevant, science missions that the Shuttle can be used for. One such mission is *a third Shuttle flight for the radar satellite, SIR-C.*

As Chairman of the full Committee, I am eager to pursue ways to strengthen and enhance the Nation's remote sensing capabilities. That is why I am intensely interested in this new radar satellite technology. In many ways, this new technology will take current remote sensing capabilities like *Landsat* to the next level.

For example, like all satellites relying on optical imagers, *Landsat* satellites cannot see through cloud cover. As a result, users of *Landsat* data sometimes have to wait for clear skies to get the pictures they want. Radar satellites do not have that constraint. Because radar satellites employ *radio waves* to generate their images,

the radar satellites can "see" through cloud cover. For a rural state like my home state of South Dakota, radar satellites hold special interest since they can provide data about soil moisture, crop and vegetation classification, crop health, and the water content of snow. In addition, a radar satellite can reveal *elevation data,* which can be integrated with current *Landsat* data to provide three-dimensional Earth images. Equally exciting, when these satellites are flown as clusters, they can measure ground movements *of as little as one centimeter.* This information will greatly help scientists in understanding and predicting earthquakes around the world. The applications of this technology seem truly limitless. This fact is not lost on Japan and Europe, which already operate radar satellites, or on Canada, which is launching one later this year.

I am hopeful NASA will give serious consideration to a third Shuttle flight for the SIR-C payload. I also believe NASA should follow up any such mission with an operational radar satellite program so the U.S. is not left behind in this important remote sensing technology. I would expect the radar program to make maximum use of existing remote sensing assets such as *Landsat* and the *EROS Data Center,* which archives the *Landsat* data.

Mr. Chairman, I note this hearing will also examine NASA's proposal for a new Reusable Launch Vehicle program which is aimed at *eventually* developing a replacement for the Shuttle. I fully appreciate the potential benefits of such a system both for NASA and the commercial market. However, given the constraints of NASA's five-year plan, it is difficult to see how this program can be afforded. NASA will be doing well just to continue the current programs in its operating plan. I remain open-minded, though, and I am eager to hear how NASA plans to pay for this effort, particularly in the out years.

I would also like to take this opportunity to extend a welcome to our colleague from the other body, Chairman Rohrabacher.

Mr. Chairman, let me also welcome this distinguished panel of witnesses to our Subcommittee. I look forward to hearing their testimony.

STATEMENT OF REPRESENTATIVE DANA ROHRABACHER, U.S. CONGRESSMAN FROM CALIFORNIA

Representative ROHRABACHER. Thank you, Senator, and I appreciate the fact that this hearing is taking place and your personal attention to this issue, because I believe that what we are really talking about today is the future of America's ability to compete in space exploration and utilization.

Is America going to be the technological leader? Is America going to be the leader in space? And what role will the Space Shuttle and reusable single-stage-to-orbit launch vehicles play in our drive for leadership?

And just to start off, I would like to say about the Space Shuttle that as part of our cold war space program, the Space Shuttle was a tremendous success. And as you have noted in your opening statement, the Space Shuttle was and is a marvel of technology.

But the Space Shuttle is also risky. No matter how much we do to try to take the risk and minimize the risk, it is still a very risky piece of technology. And it is horrendously expensive to operate.

And depending on how you calculate it, I understand that the Space Shuttle costs at least half a billion dollars per flight. That has to come down. That has to come down, and in the short run.

I mean, I remember the pictures of our astronauts pulling a disabled communications satellite into the Shuttle. And then you find out that the Shuttle flight cost about twice as much as the satellite itself, which makes no sense in any businessman's mind.

Unfortunately today, the Shuttle is about all we have to launch large cargos and all we have, of course, to put people into space. For example, it is the vehicle we are going to rely on, because we have to, to launch the Space Station's modules.

So in the short term, what we have to look at is streamlining the Shuttle program, which is what you were talking about in your opening statement. And we have to take a look at all of the ideas and how to approach it.

Mr. Chairman, I compliment you. You went through a lot of the decisions that have to be made when looking at this problem.

We should be moving to a single prime contractor so that we will have less redundant government oversight. And hopefully, I would think that we could privatize the whole system eventually.

There are different ways of looking at the Shuttle, as I say. One is that technologically, it is a great achievement. Another is that it is a risky program.

But let us note this, that if we are going to have cheap and regular access to space, if we are going to be the leader in launch technologies, we have to move beyond the Shuttle.

The Shuttle is not serving us well to the degree that it keeps us back in the 1980's and even in the 1970's in terms of technology.

That is not the fault of the designers or the people who are operating the system today. It is just a matter of fact. For anything past the short term, we need to dramatically accelerate NASA's effort to develop new technologies which will enable cheap and reliable and frequent access to space.

While we want to streamline the Shuttle program in the short term, in the medium and long term, we have to find cheaper and more reliable ways of getting into space.

NASA has decided that single-staged-to-orbit technology, which enables totally reusable launch systems, is the best option on the intermediate and long-range horizon. And to develop and to demonstrate SSTO technologies, NASA has gone back to the old idea of X vehicles. And I will have to say that I, of course, have been an advocate of that.

Rather than pushing technologies and building an operational system at the same time, which is what they did with the Shuttle program, NASA is pursuing the hard technological research that the private market cannot and will not fund.

But they are doing this in cooperation with industry so that once the technological risks are brought down, that private companies can then step in and build low-cost and commercial launch systems that can provide a free market launch service to the American people and to international customers.

NASA's SSTO effort is the X–33 project, which is part of their Reusable Launch Vehicle program. Phase one of X–33, which will compare three different designs, is already underway. In fact, I understand the X–33's precursor, Delta Clipper Experimental is having a test flight today in New Mexico.

Next summer, NASA hopes to select one or two of the three designs that are in competition for SSTO. These will be developed over the next 3 years and flight tested in 1999.

NASA's Reusable Launch Vehicle program also includes some important ground-based technology, as well as an upgrade to the DC–X itself, and a separate, small two-stage booster called the X–34.

But the key to the effort is the X–33 itself. Like the X–1 and X–15 experimental planes of the past, the X–33 will push the state-

of-the-art and make possible a whole new generation of commercially-developed and operated SSTO launch vehicles.

I believe we are going to be competitive in the future, because this technology will leap frog all the other launch technologies in the world, whether it is the Russians or Chinese or whomever. Therefore, I believe we should fully fund, and even accelerate, the X–33 program.

I am also asking the committee, and I understand the budget restraints that you are under, I am asking the committee to increase the fiscal year 1996 authorization level for phase two of the X–33—development and flight testing the vehicle, that is—from $43 million to roughly $100 million.

I am asking the committee to join us on the House side in providing aggressive oversight of NASA's efforts to ensure that we get a true X vehicle and not just another part X, part prototype, part operational hybrid that would result in nothing more than a "Shuttle II" or something like that.

I am not worried about NASA's leadership right now, but there are some people in NASA, and there are some people in the industry, in the sort of built-in bureaucracy that we have going in our space industry, who have done everything they can to stop the development of this new technology.

They are very—you know, they are set in their ways, and they are used to the way things are.

And we have had a lot of trouble, and SSTO research has been delayed, for 2 years, inexcusably delayed for 2 years, because people in the system have put up roadblocks just to prevent change.

Mr. Chairman, to conclude I would like to say that we cannot continue spending so much money in order to put things into orbit. That is the huge stumbling block we have to space utilization and to space exploration and commercialization.

If we can just bring down that cost, we are halfway to the Moon, Mars, or anything else that we want to do, to mining the asteroids, to tremendous utilization of space for the benefit of mankind, if we can just get over this one hurdle, which is the cost of getting into orbit.

The Shuttle has been a technological marvel, but it is time to move beyond it. And we have to do it by developing new technologies that will permit us to be the leader in the future and have the high ground against all other countries.

So I appreciate the chance of testifying today and your interest in this project.

Senator BURNS. Thank you very much, Congressman. You are the Chairman of the Subcommittee on Energy and Environment of the House Science Committee. Congressman Walker is your chairman, I think, and you have visited with him about this.

I will not ask you on what his feelings are, because I think it is about time that maybe we should sit down with the chairman and also my chairman here and plot a course which will be appreciate. You are a great supporter of the X–33 program. Tell me right now: Are you happy with the progress that we are making so far?

Representative ROHRABACHER. Well, actually I am not, because I think we should be much further along than we are.

I think it took a long time to get people who were basically tied to the old technology, both in terms of making money and conceptualization, to get beyond the old technology and old way of doing things and to realize that with new composite materials and basically the information that we gleaned from the old National Aerospace Plane program, that we now have new potential.

It took us far too long for people to realize that NASP took us to a new level where we can now achieve SSTO rockets.

And I think that we have been delayed for about two or 3 years here because people have yet to grasp how much potential SSTO can give us.

Senator BURNS. Congressman, we thank you for coming this morning. If you would like to join us and hear the rest of the testimony today, you are certainly welcome to do so.

We also understand that you are a little bit busy on the House side. One has to do what one has to do. But you are sure welcome to stay, if you choose to do so. And thank you for coming over this morning.

Representative ROHRABACHER. I appreciate that, Senator.

[The prepared statement of Representative Rohrabacher follows:]

PREPARED STATEMENT OF REPRESENTATIVE DANA ROHRABACHER

The future of U.S. space utilization and exploration depends first and foremost on radically reducing the cost of launching people and payloads into space, achieving what space advocates call Cheap Access To Space. That goal both enables and depends on Americans' vision of space as a frontier. After all, if space is just a government program then cheap access is a matter of how efficiently the government launches its employees and experiments. But if space is to be opened to all, then cheap access is essential.

Today I want to speak about NASA's Space Shuttle and Reusable (Single Stage To Orbit) Launch Vehicles programs in the context of Cheap Access to Space. By many standards, the Space Shuttle has been a tremendous success. It is a marvel of technology. Underfunded from the start, it is in effect a prototype which we pressed into operational service.

But as a consequence, the Space Shuttle is risky. It is not perfectly safe. The astronauts, engineers, and technicians who make it fly safely are American heroes for their effort and achievement, but they shouldn't have to do that a day longer than necessary. The Shuttle is also costly. Because the system requires a "standing army" to launch and months of servicing between launches, it is horrendously expensive to operate. Depending on how you calculate it, a Shuttle flight costs between one half billion and one billion dollars.

Unfortunately, today the Shuttle is all we have in the U.S. to launch people and large cargoes—such as Space Station modules—into space. So for the short term we must streamline the Shuttle program as much as possible. That means moving to a single prime contractor with less redundant government oversight, and eventually privatizing the system entirely.

Measured against the new goal of opening up space through cheap and regular access, the Shuttle is a failure. Again, that's not the fault of its designers or operators; they did the best they could at the time. But times have clearly changed.

For anything past the short term, we need to dramatically accelerate NASA's efforts to develop technologies which enable cheap, reliable, and frequent access to space. NASA has decided that Single-Stage-to-Orbit, totally reusable launch systems are the best option on the immediate horizon. SSTO means you don't have multiple-piece rockets which have to be recovered or replaced and put back together again. You have a "one piece" vehicle which lands, is refueled, gets minimal servicing, and then takes off again, much like airplanes do today.

To develop and demonstrate SSTO technologies, NASA has gone back to an old idea: X-vehicles. Rather than pushing technologies and building an operational system at the same time, as they did in the Shuttle program, NASA is pursuing the hard technological research that the private market cannot and will not fund. But they are doing this in cooperation with industry, so that once the technological risk

is reduced, private companies can then build an operational system which will dramatically reduce launch costs to commercial and government customers.

NASA's SSTO effort is the X-33 project, part of their Reusable Launch Vehicles program. Phase I of the X-33, which will compare three different designs, is already underway. Next summer, NASA hopes to select one or two designs that will be developed over the next three years and flight tested in 1999.

NASA's RLV program also includes some important ground-based technology development and the DC-XIA project, both of which will feed their results into the X-33, as well as a separate small reusable two-stage booster, the X-34. But the key is the X-33 itself. Like the X-1 and X-15 experimental planes of years past, the X-33 will push the state of the art to enable dramatically improved space access. It will make possible a new generation of commercially-developed and operated SSTO vehicles which will allow us to phase out the Space Shuttle—along with its high costs and risk—early in the next decade.

It is therefore vital that we fully fund—even accelerate—the X-33 program. I am asking the Committee to increase the FY96 authorization level for Phase II of the X33—development and flight testing—from $43 million to roughly $100 million. But I am also asking the Committee to join with us on the House side in providing aggressive oversight of NASA's efforts, to make sure that we get a true X-vehicle and not just another part-X, part-prototype, part-operational hybrid—in other words, a "Shuttle II". I'm not worried about Dan Goldin's or Jack Mansfield's commitment to developing the right X-33, but rather the NASA and industry bureaucracy who are wedded to older ways of doing business.

We should remember tat the Defense Department started a Single Stage Rocket Technology program back in 1990, which led to the successful DC-X vehicle, which was built by McDonnell Douglas. But we've had to fight year after year to keep anti-space bureaucrats and defenders of throwaway or expendable launch vehicles from killing the DC-X. Finally, President Clinton gave the lead on SSTO research to NASA, with the Air Force continuing in a cooperative, supporting role. Meanwhile, all the bureaucratic nonsense has delayed us by at least two years.

Mr. Chairman, we can't keep paying today's space launch prices one day longer. We can't put off giving NASA the economic rationale of advancing space commercialization by pushing Cheap Access to Space one day longer. And we can't delay offering our children and grandchildren a hopeful vision of an open frontier in space one day longer.

As President Reagan told us: "We have every reason to dream great dreams...after all, we're Americans." We need to make NASA's X-33 Single Stage to Orbit project work, and just as soon as possible. America's future in space, and on Earth, depends on it.

I'd be pleased to try to answer any questions you may have.

Senator BURNS. Our next panel will be Dr. Wayne Littles, Associate Administrator of NASA's Office of Human Flight, which manages the Shuttle program. And the full panel will come forward now, and we will introduce those folks to you as they come forward.

By the way, while this panel is coming forward, I want to extend the thanks to the NASA folks. Last Friday we had the opportunity to go down to Langley and to visit some of the facilities down there, their air tunnels, or their wind tunnels, and to see some things that they are doing with aging aircraft and the technology that is being carried on down there. And we appreciate that trip very much.

So we made a wonderful Friday afternoon out of it, and we appreciate that, although we were a little late leaving this 13 square miles of logic-free environment here just to get down there.

Dr. Wayne Littles, who is the Administrator of the Office of Space Flight, and Dr. John Mansfield, Associate Administrator of Space Access and Technology, are with us this morning; Dr. Jerry Grey, Director of Aerospace and Science Policy at the American Institute of Aeronautics and Astronautics; Dr. Paul Johnstone is here this morning, Deputy Chairman NASA Aerospace Safety Advisory Panel.

Mr. Logsdon did not make it. Oh, there he is right there. There you go. He is Director of Space Policy Institute at George Washington University.

So we appreciate you coming in this morning.

And, Dr. Littles, we will start with your statement.

STATEMENT OF DR. J. WAYNE LITTLES, ASSOCIATE ADMINISTRATOR FOR OFFICE OF SPACE FLIGHT AT THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. LITTLES. Thank you, Mr. Chairman.

I am pleased to be here this morning to discuss the status of the Shuttle program and to discuss changes that we are proposing to make to the program and to discuss some changes that have already been made.

The Shuttle, of course, continues to be highly successful in meeting its mission objectives. During fiscal year 1994, we took advantage of the full range of capabilities of that vehicle, which is much more than just a launch vehicle, as you are aware.

We successfully completed all the missions that were manifested. Carrying payloads to space and conducting a wide range of science with the Shuttle as the platform. Micro-gravity, life sciences, earth and atmospheric sciences were all conducted, and of course, we returned those payloads to earth.

We also completed the highly successful Hubble Space Telescope Servicing Mission during that year, using the capability that is provided by that system to do that kind of job.

And thus far in 1995, we have successfully flown three missions out of seven that we have planned. Of course, one of those was the very successful rendezvous with the Space Station Mir that we have recently conducted.

And in June, we will fly the first mission and dock with Mir, conduct some experiments while we are there, transfer crews and bring a crew back to earth. And, of course, that will be a major step in our phase one Space Station program preparing to build the International Space Station.

The Shuttle program, of course, also continues to reduce costs and increase efficiencies while improving the safety and reliability as we go forward. And as you have already mentioned, since 1992, we have in effect decreased the budget by 24 percent per year.

In the process of doing that, we have reduced about 5,600 or about 22 percent of the contractor work force and about 14½ percent or 550 of the government work force that are working on that program.

During the budget process last year, there were some concerns raised by some that we might have been moving too fast, might have lost our baseline. As a result of that, we conducted detailed reviews.

We conducted a detailed internal review, and there have been external reviews as well. And we have confirmed that there are no safety impacts to the changes that we have made so far.

Having said this, though, we fully recognize the need to implement additional improvements. We accept the principles that are contained in the report that Dr. Chris Kraft and his team have recently provided.

Those recommendations confirm many conclusions that had been established with the agency from time to time.

And I am, along with the senior management in the Office of Space Flight, working to further define those recommendations that were given by Dr. Kraft and his team.

We are working to reduce the requirements, and that was one of his recommendations, consistent with our operational experience. We are moving to define a significantly reduced government role in that program with respect to operations.

We are moving to modify and improve our approach to Safety and Mission Assurance. And we are moving to define the means to restructure the significant number of contracts that we now have working on the Shuttle program.

These changes, when we implement them, will enable us to achieve additional savings and will play a major role in meeting the additional reductions that were imposed on the agency in the fiscal year 1996 budget, which was submitted in January to the Congress.

As we examine the program restructuring over the next few months, we will begin to establish what we will find to be a minimum level of funding required to safely operate the Shuttle.

While there is a great deal of work to be done prior to our submission of the 1997 budget, I feel confident that we will be able to meet the challenge that was imposed by that 1996 budget submittal.

However, at this point in time, I do not know how we can accept additional challenges beyond that level. And I can assure you that the Shuttle program will not agree to funding levels that jeopardize safety. Thank you.

Senator BURNS. Thank you, Dr. Littles.

Senator BURNS. Dr. Mansfield.

STATEMENT OF DR. JOHN MANSFIELD, ASSOCIATE ADMINISTRATOR FOR SPACE ACCESS AND TECHNOLOGY AT THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Dr. MANSFIELD. Thank you, Mr. Chairman.

I am pleased to be here, and I would like to submit a written statement for the record.

Senator BURNS. Without objection. All your written statements will be entered into the record, and you can summarize, if you wish to.

Dr. MANSFIELD. Mr. Chairman, I would like to discuss NASA's new Reusable Launch Vehicle program and point out some of the unique issues addressed by this program. As you know, it is a fast-paced program, tightly funded, with an aggressive, small management team.

But principally what is different about this program is that it is a government-industry partnership. We are putting money on the table. Industry is putting money on the table.

The purpose of the program is to mature and demonstrate the technologies that would be needed for industry to make a decision—not the government, industry to make a decision—early in the next century to build a money-making, large-scale launch vehicle that will take the place of most or all of our expendable launch

vehicles and will provide us that long-sought, cheap and reliable access to space, access to space that will allow us to build large-scale industrial facilities in space, access to space that will allow us to have many people constantly in near-earth orbit, engaged in commerce and science and preparing us to move to the planets.

It is only by having large-scale access to low-earth orbit at low cost that low-earth orbit will ever be a frontier to exploration of the universe. Otherwise, it is going to be a frontier to a wasteland, because we cannot get enough people there. We cannot get enough laboratories there. We cannot get enough facilities there. We cannot build and move to the planets unless we can get low-cost to space. It truly is the goal.

And that is why it is Administrator Goldin's highest priority, as he has insisted to us over and over again.

Because it is his highest priority, we have completely and totally funded this program in the 5-year budget that we are putting together.

We will not require new funds beyond the 5-year budget that we put together.

The Reusable Launch Vehicle program is a technology demonstration program in particular. When it results in an industry decision to build a large-scale launch vehicle, that is going to be a multi-billion dollar program, a program like a Boeing 777.

It is a program that industry will move on to when it is sure that it can make money at it and it is sure that the technologies are there to support it. We believe the program that we put in place can enable them to do that.

Recognize that the government will not own this system. The government will be a paying customer, probably a very important one, but it will be a paying customer for a system that makes money by taking large-scale industrial activities into space.

We are not doing this program in the way the government has in the past, as overseers or managers, of a technology development. We are partners with industry and not their managers.

The management structure for this team is extremely lean. The manager for the X–33 program, for instance, is Gene Austin. He has two people working for him. He reports to Gary Payton. Gary Payton reports to me.

That is the entire X–33 management program. No money is spent in that program except by those people. There are not any marching armies whittling away the money.

If there are other people at NASA working on the X–33 program, it is because industry asked them to. In particular,

McDonnell Douglas has asked Marshall Flight Space Center to build and test certain graphite epoxy cryogenic components as subcontractors to McDonnell Douglas. So it is not the normal government program.

The other programs, the DC–XA, which, as Congressman Rohrabacher said, should fly today, and the X–34 are equally lean. The total number of management people at NASA in this program is 12.

Now, those 12 people cannot do everything that the government has to do on this program. There are things that the contractors will continue to ask NASA to do, in particular things to do with

advanced composites and engines, because the government knows more about those things than other people.

The program is supported by components and ground test program that has been going on since 1994, early 1994. It is focused on light-weight vehicles with robust composite components, very high margins, low change-out requirements, automatic systems, automatic vehicle health monitoring systems, geared at low maintenance and rapid launch turnaround times.

The only operational goal that we set for the program—we set no programs and no specifications for this program.

We set goals in a cooperative agreement.

The only operational goal that we set is that they should be able to turn this vehicle around in a week with something like 50 people, that they should aim for a goal like that. That is, again, not a spec.

Now, let me explain for a minute what we see the relation of the Reusable Launch Vehicle, successful Reusable Launch Vehicle, program to the future of the Space Shuttle and other national space launch systems.

If we succeed in our technology program, industry will be able to move forward to develop Reusable Launch Vehicle program.

If they succeed in developing that Reusable Launch Vehicle program, the full-size operational reusable launch vehicle will be far cheaper to operate than anything we have now. So certain Shuttle missions could immediately be done by reusable launch vehicles at lower cost.

Certain station resupply missions could be done that way. Eventually, we could consider phasing down and phasing out the Space Shuttle and the Titan and Atlas and Delta systems when the Reusable Launch Vehicle has proven itself to be safe, reliable and cheap.

If we do not meet those requirements for technology to allow that decision, we are going to have to face a decision at the end of this decade, early part of the next century, to make the large-scale investments and upgrading the Shuttle to maintain safety and performance and to carry manned space flight on past the first decade into the next century.

That is what we see is the importance of this program. If we do not succeed in demonstrating the technologies required for the Reusable Launch Vehicle, we will be faced with a far larger investment in the future to maintain the Shuttle program.

So in conclusion, Mr. Chairman, I think this is a challenging course, but it is achievable. I think the goal of affordable, privately owned access to space is a realistic one.

I think the technologies are in hand. I think we are making good progress toward that goal. And I look forward to working with the committee in bringing this project to a successful conclusion.

Thank you.

Senator BURNS. Dr. Mansfield, thank you very much.

[The prepared statement of Dr. Mansfield follows:]

PREPARED STATEMENT OF DR. JOHN E. MANSFIELD

Mr. Chairman and Members of the Committee: I am pleased to be here today to discuss NASA's challenging and exciting Reusable Launch Vehicle (RLV) program

and its relationship to the future of the Space Shuttle and other national space transportation systems.

Mr. Chairman, I will not attempt to describe the RLV program in detail, but rather will set the larger policy context, broadly outline the basic program itself, and then focus on its implications for the future of U.S. space transportation.

NASA's RLV program is a fast-paced, tightly-funded, aggressively-managed, Government-industry partnership designed to mature and demonstrate the technologies essential for fostering the post-2000 new generation of U.S. space launch systems.

It is aimed squarely at achieving a long-sought, fundamental goal of U.S. National Space Policy: Affordable and reliable access to space. The current high cost of space access continues to be the single largest barrier to fully utilizing the unique and richly promising environment of space. Low-cost and reliable access will truly open and expand the frontiers of space, leading to new plateaus of advancements in science, medicine, commerce, national security, and other benefits for the American people and all humankind.

The National Space Transportation Policy, as revised by the President in August 1994, designates NASA as the lead agency for technology development and demonstration of next-generation reusable space transportation systems, including the promising Single Stage To Orbit (SSTO) concept. It also envisions the U.S. private sector playing a significant role in the development and operation of full-scale, operational next generation systems.

The policy calls for NASA to focus on technologies that will enable a decision no later than December 1996, on proceeding with a sub-scale flight demonstration program. This technology maturation and demonstration program, in turn, will provide the basis for a Government/industry decision by the end of the decade on proceeding with development of new full-scale, operational reusable launch system(s).

To implement these roles and responsibilities, NASA Administrator Daniel Goldin, with the strong support of the Administration, has established the RLV program as a high priority, fast-track development and demonstration program focused on reducing the technical and business risk inherent in building and operating new launch systems. The primary objectives of the RLV program are to (1) mature the technologies required for next-generation launch systems; (2) demonstrate the capability to achieve low development and operations cost; and (3) reduce technical risk to levels that will attract private investment in the commercial development and operation of next-generation launch systems.

These are uniquely challenging technical as well as business objectives. To achieve them, the RLV program incorporates several approaches that are nothing short of revolutionary in NASA's way of doing launch systems development.

First, we are working in close partnership with—not oversight over—industry. Over the past year, we have concluded more than a dozen cooperative agreements with aerospace firms to cost-share and jointly manage the key technology component and flight project segments of the RLV program. This ensures that the best mix of Government and industry resources and expertise are applied to every step of the development and demonstration process.

Second, using these partnerships, we are mounting a vigorous and extremely fast-paced five-year program of technology development centered around a balanced program of ground-based and flight-environment testing—emphasizing smart, lightweight, reusable, robust advanced components; high-margin, low change-out engines; automated take-off and landing; small ground crews; low maintenance; and, rapid launch turnaround times. This includes:

-- the DC-XA vehicle, initially developed and demonstrated by DOD as the DC-X, and transferred to the RLV program for upgrading and flight testing by mid-1996. These flights will test advanced technologies such as composite graphite tanks and intertank structures, and hydrogen leak-detection sensors;

-- the X-34 small-booster demonstrator flight tests, scheduled for late 1997-early 1998. These flights will validate less costly, more operable components, and demonstrate industry-led management as well as the economics of reusability. This project is cost-shared with NASA's contribution capped at $70 million, and industry providing more than an equal amount; and

-- the X-33 advanced technology demonstrator—the centerpiece of the RLV program. The X-33 will build on the results of ground-based component testing, the DC-XA, and the X-34, to integrate SSTO-based vehicle components, operations, reliability, and business-management aspects. This project, assuming a go-ahead from the President no later than December 1996, will be cost-shared with industry and will form the basis for scaled-up post-2000 next-generation commercially-built and operated RLV systems. Flight tests are planned for no later than July, 1999.

We are confident that this technology maturation approach will result in significant advances in reliability, operability, safety, responsiveness, and reduced cost—

and, in turn, produce a sound basis for informed decisions by the end of the decade on whether and how best to proceed with commercial fleet production and operation.

The final "revolutionary" approach we have taken deals with NASA's internal management approach. Administrator Goldin and I have designed a small, streamlined, highly accountable RLV program management structure in my office under the leadership of Col. Gary E. Payton (USAF-Ret.) who directs 12 NASA managers working with their industry counterparts to conduct all three flight vehicle projects and supporting technology development described above. This produces only three layers of management compared to at least five conventionally, and reduces NASA engineering personnel from the usual eighty-plus to about four. This team is also working very closely with Air Force and other DOD personnel in tapping their RLV and SSTO expertise and resources.

Mr. Chairman, let me now turn to the implications of the RLV program for the future of the Space Shuttle and other national space transportation systems.

The RLV effort is embarked on a path to enable affordable and reliable access to space provided by commercially-built and operated launch systems. The resulting full-scale, operational vehicles will be sized and operated by the private sector in response to launch market demand. It is a goal that a significant amount of the demand be generated by NASA and other Government agency launch needs.

In this respect, a major transition is expected to take place in the early decades of the post-2000 era with regard to all Government-utilized launch systems, including the Space Shuttle, expendable launch vehicles (ELVs), and evolved expendable launch vehicles (EELVs). This will be a transition toward utilizing commercial RLVs that meet Government and private sector launch demand at lower cost and greater reliability.

Under this scenario, beginning after about the year 2005, the commercial RLVs could fulfill certain Shuttle missions at significantly less cost than the Shuttle fleet. This could include, for example, Space Station resupply and crew change-out missions.

In this regard, it is important to note what the RLV is not: It is not a "Shuttle II," nor a piloted vehicle, nor will it perform crew-tended research for weeks on-orbit, nor astronomy and Earth remote sensing. These capabilities will be assumed by the Space Station.

Therefore, a successful RLV development and demonstration program can enable the birth of efficient and low.cost commercial launch systems, and NASA can begin the phase-down and eventual phase-out of the Space Shuttle fleet as well as, presumably, some or all of the Titan, Atlas, and Delta-class ELV/ELV systems—resulting in great savings to the Government as a whole in the early decades of the 21st Century.

If the RLV program objectives are not met by the end of the decade, the need would be triggered for a concurrent decision concerning a substantial upgrade of the Space Shuttle, including possible fleet augmentation, to maintain the safety and reliability of the Shuttle.

In either event—operational RLVs or upgraded Space Shuttle system—NASA will move to meet its mission requirements at the lowest-cost, most reliable means available at the time.

Mr. Chairman, NASA's RLV program charts a challenging but, we believe, achievable course toward attaining the national space policy goal of reliable and economical access to space. While the goal remains technically difficult, emerging advanced technologies, developed and demonstrated by the right mix of Government-industry cooperation, will make it increasingly attainable.

The real payoff will be the post-2000 production of low-cost, reusable space transportation systems that not only meet the Government's civil and national security needs, but can be fully commercialized and used competitively by U.S. space industry and business to strengthen our world role in space transportation and space utilization.

We look forward to working with the Subcommittee on this crucially important endeavor.

Senator BURNS. Dr. Grey; Dr. Jerry Grey, Director of Aerospace and Science Policy at the American Institute of Aeronautics and Astronautics, AIAA.

Thank you for coming this morning.

STATEMENT OF DR. JERRY GREY, DIRECTOR OF AEROSPACE AND SCIENCE POLICY, AMERICAN INSTITUTE OF AERONAUTICS AND ASTRONAUTICS

Dr. GREY. Thank you, Mr. Chairman.

The AIAA is a non-profit technical society of over 40,000 aerospace professionals. We focus on the technical considerations that underlie policy decisions and civil aeronautics and space programs. We welcome this opportunity to present our views.

First, I want to strongly endorse Mr. Rohrabacher's opening statement. It sets the framework and the basic rationale for my comments here today.

First, you asked to address the current status of the Shuttle program. The program appears healthy. The Space Shuttle Management Independent Review Team, the Kraft Committee, found it be successful, operating a mature and reliable vehicle. They have assessed the program carefully. We agree with their conclusions and recommendations.

Next you asked us to look at Shuttle program organization. We know it is essential to maintain Shuttle operations until a suitable successor has been developed and demonstrated.

However, it is costly to operate, and it is marginal in its ability to deploy International Space Station Alpha in its present configuration.

NASA has been successful in cutting costs by 25 percent (as Mr. Littles noted), as detailed in our statement. The NASA

Zero–Base Review concluded that further cost reduction and improvements could be achieved by assigning Shuttle operations to the Kennedy Space Center and making several other management-oriented changes.

The Independent Review Team went one step further, recommending that Shuttle operations be consolidated under a private-sector, single-business entity. This is not a new idea. We have listed in our statement many prior proposals to privatize the operation of government-developed launch assets, which go even beyond the Independent Review Team's recommendation. These proposals go back almost three decades. They have addressed many of the issues you, Mr. Chairman, raised in your opening statement.

Now, these recommendations for privatization were rejected at first because it was argued the Shuttle was still a developmental system. Later, there was always an upcoming critical mission whose safety might be prejudiced. Finally, after the Challenger accident, it was difficult to get people to accept responsibility that might prejudice safety.

Current budget pressures, however, require that these barriers to privatization, whether real or perceived, be addressed and surmounted. Everyone seems to agree that NASA should not be responsible for mature system operations.

The review team concluded that the Shuttle is a mature system. Hence, the AIAA supports the review team's recommendation for transferring Shuttle operations to a single business entity, rather than taking the interim step of assigning operational responsibility to KSC, which would keep a purely operational function within NASA. Among the benefits of that approach is that it would allow the basic change in culture that seems to be needed to overcome

the inertia of the NASA bureaucracy that has built up over the years.

To increase the Shuttle's performance margin for the high-payload Space Station deployment missions without compromising safety or exceeding allowable budgets, we support Shuttle designer Max Faget's suggestion to reconfigure one orbiter for unpiloted, cargo-only operations, increasing its payload capacity by over 12,000 pounds without lightening structure or tankage and without having to increase engine thrust, both of which could have negative cost and safety implications.

This was also pointed out by the Independent Review Team.

On Space Shuttle safety, we of course recognize that safety must be paramount. Nevertheless, it is possible to streamline procedures without prejudicing the assurance of safety. Our written statement gives some examples. The review team has addressed this subject in some detail.

Finally, I would like to speak on the Reusable Launch Vehicle program. The rationales for the X–33 and the X–34 are clear: The X–33's goal is to reduce the technical risk for development of a full-scale operational launcher and thereby make it possible for industry to invest in that development, as Dr. Mansfield has pointed out. The X–34 will test a new management approach, whose linchpin is government-industry cooperation. It lays the groundwork at very low cost for the much larger and more important full-scale launch vehicle program that will evolve from the X–33. At the same time, the X–34 provides NASA with a valuable early test bed for X–33 technologies and also opportunities to test outside the X–33 envelope. It is the X- 15 of the 1990's.

NASA gets a technology driver and a test bed for key X- 33 technologies, industries gets a prototype for a profitable commercial product, and at long last we finally set up a government-industry teaming mechanism like those that have proved so successful in Japan and Europe.

The government expects industry to finance the full- scale operational successor to the X–33, as Dr. Mansfield has pointed out. The conventional approach to launch system development, in which the government foots the entire bill, is no longer viable.

Conversely, industry cannot be expected to invest capital unless there is a reasonable prospect for return on its investment. It is also necessary to reduce technical risk before proceeding with full-scale development. That is what we expect from the X–33 program.

Industry should undertake the development of the operational system provided there is a reasonable, low-risk return on its investment via government purchases of launch services. Shouldering the market risk, as distinguished from technical risk, is generally recognized as being industry's responsibility.

One final issue: Should NASA mandate that the RLV be a single-stage-to-orbit (SSTO) configuration? Although SSTO flight has many benefits, the technical risk of achieving the necessary performance is high.

If an SSTO configuration proves able to meet both performance and operational goals, it should certainly be chosen. But defining the optimum configuration is a major objective of the X–33 program. NASA and industry should pick the system that offers lowest

cost, highest reliability and best operational features, whether it turns out to be SSTO, boosted, two-stage or uses drop tanks. The last thing we need is yet another launch system that has to squeeze out every last ounce of performance the way our present launchers do. Every blue ribbon panel has agreed we need a robust, low- cost vehicle with conservation design margins. That goal could be prejudiced if the vehicle is constrained to a pre- determined configuration.

The RLV program has finally given industry and government an opportunity to work together and develop the operationally viable launcher everyone says we have needed for decades.

Let's not blow it by trying to second-guess the outcome. Thank you, Mr. Chairman.

Senator BURNS. Dr. Grey, thank you very much for coming this morning.

[The prepared statement of Dr. Grey follows:]

PREPARED STATEMENT TO OF DR. JERRY GREY

Mr. Chairman, Subcommittee members, I am Jerry Grey, Director of Aerospace and Science Policy for the American Institute of Aeronautics and Astronautics (AIAA). The AIAA is a nonprofit professional society of over 40,000 aerospace professionals whose mission is to advance the arts, sciences, and technologies of aerospace. We have testified on the civil aerospace program at hearings held by previous Congresses. Our viewpoint is based primarily on the technical considerations that underlie policy decisions concerning the U.S. civil aeronautics and space programs. Because the AIAA represents such a broad spectrum of the aerospace community, it does not reflect the provincial viewpoint of a single constituency, but provides a balanced perspective of the profession as a whole. We welcome this opportunity to comment on NASA's space transportation programs.

You have asked for our views in five areas: (1) the status of the current Shuttle program, (2) the proposed reorganization of Shuttle-related responsibilities among the NASA centers, (3) the merit of proposals to "privatize" the Shuttle program, (4) the potential impact of budget cuts on Shuttle safety, and (5) NASA's new Reusable Launch Vehicle (RLV) program.

(1) Status of the Current Shuttle Program

The current program appears healthy, and with the exception of the recent decision to reduce flight rate from eight to seven missions annually, does not appear to have suffered, either in safety or in flight operations efficiency, from the significant Shuttle program budget cuts of about 25% during the past three years. The February 1995 report of the Space Shuttle Management Independent Review Team found the current program to be "successful, operating a mature and reliable vehicle." However, costs still remain high, program management is overly diverse at all levels, and there is some concern about the increase in performance that will be required for several International Space Station Alpha (ISSA) deployment missions later in this decade. We discuss these concerns in more detail later.

(2) and (3): Space Shuttle Program Organization

The Shuttle is the only U.S. transportation system qualified to carry humans into space. On the premise that our national space program cannot be complete without the presence of men and women in space—a premise both the nation and the AIAA have long insisted upon—it is therefore essential to maintain Shuttle operations until a suitable successor has been developed and demonstrated. However, as we mentioned earlier, the Shuttle is costly to operate and is marginal in its ability to perform part of its most important near-term mission: supporting the deployment of International Space Station Alpha.

Resolution of the cost issue has been sought by NASA during the past few years, with some success. The 25% cut in Shuttle costs was achieved by eliminating duplication and/or parallel activities, weeding out obsolete procedures and requirements, reassigning responsibilities among NASA personnel and contractors to maximize productivity, introducing "Structured Surveillance" to give technicians more direct responsibility for work quality, and other similar actions. Further cost reductions

that could be implemented without compromising safety have been explored. The NASA Zero-Base Review concluded that such cost reduction, with its attendant improvements in operations efficiency, would best be achieved by assigning all responsibility for Shuttle operations to a single entity: the Kennedy Space Center. The Space Shuttle Management Independent Review Team went one step further, recommending that Shuttle operations be consolidated under a private-sector, single-business entity.

This is not a new idea. Prior proposals to privatize government-developed launch assets go back almost three decades, to Transpace (1967), OTRAG (1974), Earth/Space Corporation (1976), Earth-Space Transport Systems (1978), the Space Transportation Corporation (1979), Space Services, Inc. (1980), Transpace Carriers (1982), the U.S. Space Transportation Corporation (proposed by then-NASA Administrator James Beggs in 1982), Orbital Systems Corporation (1983), Satellite Propulsion Inc. (1983), and more. There has even been one unqualified success, although not in the U.S: Arianespace (1980).

More recently the AIAA assessed the prospects for a National Launch Service Company (1988), the Air Force explored a Commercial Space Launch Industry Association (1990), the Space Transportation Association proposed Astracorp (1993), and just last year Congressman Hefley proposed the Space Launch Corporation Act (HR 4482). During the past two or three years virtually all the major space transportation contractors have conducted internal studies of potential mechanisms for joint government-industry launch service operations programs. Note, too, that the Augustine report in 1990 had strongly recommended separation of development and operational functions within NASA.

These recommendations were not implemented at first because, it was argued, the Shuttle was still a developmental system, not yet ready, as communication satellite technology was, to be turned over to a purely operational entity. Later, as former Deputy Administrator Hans Mark has noted, there was always an upcoming "critical" mission whose safety might be prejudiced by making the change. Finally, the Challenger accident, which motivated a number of excellent and useful safety procedures, also induced an understandable but unfortunate overreaction that not only increased costs substantially but also created an atmosphere in which few were willing to accept full responsibility for any procedure. Current budget pressures, however, require that these barriers, whether real or perceived, be addressed and surmounted.

Everyone seems to agree that NASA. as an agency dedicated primarily to research, technology advancement, and development, should not be responsible for system operations, especially mature systems. Having been in operation since 1981, the Shuttle must be considered mature, as the Review Team has concluded. Hence the AIAA supports the Independent Review Team's recommendation for transferring Shuttle operations to a single business entity rather than taking the interim step of assigning Shuttle operations responsibility to KSC, which would keep a purely operational function within NASA.

The benefits of having a profit-motivated Shuttle operator, along with the definition of requirements and the actions needed to make the transition effectively and smoothly, have been outlined in the Review Team's report. An important—and valid—rationale for their recommendation (instead of an operational entity within NASA) was that "...the bureaucracy that has developed over the program's lifetime—and particularly since the Challenger accident—will be difficult to overcome, and the optimum operational effectiveness of the system will be difficult to achieve, unless a new management system is provided." NASA Administrator Goldin had recognized this situation early in his tenure when he stated that the "new world order" would require a fundamental change in NASA's culture, and that it would take years to do so.

Transferring Shuttle operations to a single-business entity has raised two concerns: maintenance of adequate safety and creation of a monopoly. We will address safety later. We believe that the danger of "gouging" of the government by the Shuttle operator, as the sole purveyor of services critical to national objectives, could be alleviated or avoided by appropriate contractual stipulations, by giving oversight authority to a relatively small NASA office, and perhaps by incorporating some elements of the Comsat model, which provided government oversight initially at the "Board of Directors" level.

The second major Shuttle issue is the need to increase its performance margin, without compromising safety or exceeding allowable budgets, to meet the payload requirements for several space-station deployment missions. Shuttle designer Max Faget has pointed out that the present plan, to decrease structural weight and maintain current stress levels in the new large-throat main engines (the original motivation for the throat diameter increase was to reduce engine stresses), has both

direct and indirect cost and safety implications. His suggestion, which makes good sense, is to reconfigure one orbiter for unpiloted, cargo-only operations, increasing its payload capability to the space station's orbit by over 12,000 lb without lightening structure and without having to increase engine thrust, thereby allowing large-throat engine operation as originally planned.

(4) Space Shuttle Safety

Safety must remain the paramount requirement in space flight operations involving human crews. Hence any changes made in the Shuttle program to reduce costs or streamline management operations cannot prejudice the assurance of safety during all phases of a Shuttle mission. This has been the main concern voiced by many who believe that such assurance will be affected negatively by further cuts in Shuttle operating budgets.

As pointed out by Chairman Norman Parmet of the Aerospace Safety Advisory Panel, there is real danger that across-the-board reductions, and the turmoil they tend to create, make it difficult to define clearly at what point the crossover from safe to unsafe conditions occurs. Nevertheless, it is possible to identify procedures which can be streamlined without prejudicing the assurance of safety. For example, Faget has noted that during the initial Shuttle flight program four levels of redundancy were specified, so that if a failure did occur during countdown or launch the flight could proceed and still meet the normal safety requirement, which was three levels of redundancy. This requirement was necessary only because the hardware was as yet untried. However, NASA never relaxed the four-level requirement; indeed, Faget says, it was strengthened after the Challenger failure. Besides the extra cost and additional procedures required to assure this now-unnecessary fourth level, a failure which might have allowed a flight to proceed with an acceptable three levels of redundancy causes delays which otherwise would not be introduced.

Faget and others believe that among the numerous safety reviews, paper trails, and procedures for coordinating safety procedures among several offices having different responsibilities, there are likely to be similar options for reducing costs without prejudicing safety. Acceptable cost reductions of this type, which would preserve the required level of safety assurance, appear to be a logical consequence of the improved management process that would be implemented by a single-business entity.

(5) The Reusable Launch Vehicle (RLV) Program

Roles for NASA and Industry

The Space Transportation Policy issued by the Administration on August 5, 1994 assigned near-term responsibility for space transportation system development to the DOD and far-term responsibility to NASA. NASA began its implementation of that policy by creating a Reusable Launch Vehicle Program, under which it has issued three Phase 1 contracts to industry for advanced technology demonstration via an experimental suborbital flight vehicle designated X-33 and one contract for development of a small reusable experimental orbital flight vehicle designated X-34.

Both contracts differ from past practice; for example, industry is financing half or more of the programs' costs; specifications allow the contractors greater freedom in design and program execution with less NASA oversight, and in the case of the X-34 industry has assumed the full risk of program completion; i.e., no contract overruns. The rationale for both these programs is clear: the X-33's goal is to reduce the technical risk for development of a full-scale operational launcher, and the X-34's primary goal is to test the validity of a new type of cooperative relationship between government and industry at minimal cost, while at the same time creating a product which is expected to be of value to both.

The X-34 program is particularly important. By testing a new management approach whose linchpin is government-industry cooperation and doing so at minimal cost, the X-34 program could lay the groundwork for the much larger and more important full-scale, fully reusable launch vehicle program that will evolve from the X-33 technology demonstrator we talk about in the next paragraph. At the same time, the X-34 provides NASA with a valuable orbital testbed for X-33 technologies which cannot be fully evaluated by suborbital testing. It could be viewed as the X-15 of the 1990s—for a relatively small investment by each party, NASA gets a technology driver and testbed for key X-33 technologies, the industry gets a prototype for what could be a highly profitable commercial product, and, perhaps most important, NASA and industry finally get an opportunity to create and test a relationship comparable to the government-industry teaming that has proved so successful in Japan and Europe.

For NASA, the key policy question now is defining the role industry will play in designing, developing, and producing an operational reusable launch vehicle or vehicles that could ultimately replace the Shuttle and also provide reliable low-cost launch capability for both government and commercial users. Government policymakers have implied that they expect this next step to be financed by private industry. The necessary investment has been estimated to be of the order of at least $5 billion. However, industry cannot be expected to make that investment unless there is a real expectation of return.

Any new commercial venture requires low-risk technology and a viable market. NASA's RLV program has been designed to address the first of these needs: to reduce risk by advancing and demonstrating the key RLV technologies. But what about the market? Today government missions comprise the bulk of the launch market, so nomatter who finances the new system development the government will pay for it, either up front or in the form of user charges. Some of those who believe industry can and should make the necessary investment insist that there will be plenty of commercial customers for launches once the cost comes down; that is, "If we build it, they will come."

But according to the NASA administrator, since the commercial market is still only 20% of the total market, government needs will drive development. "Commercial payloads are a 'wisp of a promise," he has said. Most industry executives agree. They are willing to put up relatively small sums of "earnest money," as they have already done in the X-33 and X-34 contracts. But they will make the major investments needed for full-scale development of a next-generation launch vehicle only if the government guarantees a market by becoming an "anchor tenant," that is, by granting multi-year contracts to launch its payloads on the new vehicle, until the potential commercial market really appears. Those who finance the development are also certain to insist on "bulletproof" government contract termination liability insurance. Both these actions raise issues that Congress needs to address. Another concern that will require Congressional attention is that anchor tenancy contracts imply exclusion of competition from other potential launch service providers.

In summary, the conventional approach to launch system development, in which the government foots the entire bill, is no longer viable. Conversely, industry cannot be expected to invest capital unless there is a reasonable prospect for return on its investment. However, it is necessary to reduce technical risk before proceeding with full-scale development; this is the function currently being addressed by the X-33 in NASA's RLV program. Industry should undertake the development of the operational system, provided that there is some way to obtain a reasonable return on its investment with acceptably low risk; namely, a viable mechanism for assuring government purchases of launch services. Shouldering the market risk (as distinguished from technical risk) is generally recognized as being industry's responsibility.

Other considerations in the introduction of a next-generation reusable launch system include the need for a smooth, efficient transition from current systems, both government and commercial. Moreover, there are important defense applications for next-generation systems (indeed, it is possible that these requirements rather than NASA's or the commercial market's may drive system development), and therefore the DOD should be closely involved in the development process right from the beginning.

Vehicle Configuration

One final issue that has created much debate in recent months is whether or not the RLV should be mandated as a single-stage-to-orbit (SSTO) configuration. The President's August 5, 1994 policy statement explicitly calls for "a subscale flight demonstration which would prove the concept of single-stage-to-orbit." Although SSTO flight has many benefits and would certainly be the most direct path to reusability, the technical risk of achieving the necessary performance is high. We therefore believe NASA is wise in stressing reusability, low cost, "user-friendly" operational flexibility, and reliability, and leaving the specific configuration to achieve these goals up to the X-33 and X-34 contractors and, ultimately, the developer of the operational vehicle or vehicles. If an SSTO configuration proves able to meet both performance and operational goals it should certainly be chosen. If not, as NASA has noted in responding to the NASA Advisory Council's findings last December, most of the technology advancement of the RLV program would be applicable to other reusable launch vehicle configurations; e.g., airbreathing launchers or two-stage-to-orbit vehicles.

The NASA "Access to Space" study concluded that achieving the necessary mass ratio for SSTO flight is certainly feasible, but will take us to the very edges of our

technology envelope in composite materials, thermal protection systems, and lightweight alloy fabrication, all of which have yet to demonstrated, and will require an operationally sound high-performance engine that does not yet exist. Flight tests of the DC-X demonstrated key operational features of reusable space launchers. In that context the DC-X was a resounding success. Program management by both the sponsoring agency (the Ballistic Missile Defense Organization) and the prime contractor (McDonnell Douglas) was exemplary, showing that development time and cost could be cut to fractions of the customary levels without prejudicing project success. The flight tests demonstrated that highly automated launch and recovery operations of a reusable vehicle could be conducted with minimal ground support and a relatively tiny ground crew.

Partly because of this success, however, the DC-X is often credited with far more than it really accomplished (or, indeed, was intended to accomplish). Its very real achievements in motivating the President's August 5th launch policy and demonstrating operational features and management efficiency are sometimes confused with demonstrating single-stage-to-orbit system performance, which the DC-X doesn't even begin to approach. Its mass ratio, for example, was about one fifth that needed to achieve orbit.

Even after the key enabling technologies are demonstrated by NASA's RLV program, therefore, an SSTO launch vehicle would very likely have to squeeze out every last ounce of performance, just as our present launchers do. What is really needed, according to every blue-ribbon panel convened during the past decade to examine this subject, is a system having the conservative design margins that provide the robust, high-reliability, low-cost features which are key to a truly operational space launch system. We may find that the most cost-effective, reliable, operationally efficient, fully reusable launch system employs some sort of booster, more than one stage, or perhaps the drop-tank feature used for so many years by operational military aircraft, or some other as-yet unforeseeable non-SSTO design characteristic. The X-34 contractors have bet their hard-earned dollars on such a route, although of course they do not yet have the benefit of the technology advancement to be gained by the X-33 program.

In summary, the RLV program has selected the proper approach by setting performance and operational goals for a next-generation launch system, demonstrating the key technologies that would be required for any reusable high-performance system, and allowing the market and the ultimate developer to decide on a configuration that best meets the stated objectives.

Thank you, Mr. Chairman, for the opportunity to present our views on this most important subject. I will be pleased to answer any questions you or other members of the Subcommittee may have.

[The biography brief provided by Dr. Grey can be reference in subcommittee files.]

Senator BURNS. I want to just follow up on something you said, because I have a fantastic memory, but it is short. That is the reason I have to write down notes up here.

You are supporting the Kraft recommendation of privatization and also the philosophy of the one contractor, one prime contractor, on this.

Do we get into a situation where we are trying to save some dollars and yet I think in all of our minds that we are not going to sacrifice safety in this?

Do we get into a situation where oversight or NASA says this method is needed or what we are doing here to the prime contractor does jeopardize our safety record, and all at once the contractor comes back and says, "OK, I have to have more money"?

Do we get into a situation where it becomes an adversarial situation rather than a teamwork situation?

I am wondering—you know, I think there will have to be all kinds of considerations made. But how do you view that, that working partnership, that oversight, one contractor, this type thing?

Dr. GREY. Well, I think that subject has been addressed by the review team in what it calls its transition plan. In other words, you do not jump suddenly from NASA management to corporate management.

That is a major issue that needs to be resolved in the process. You decide how we are going to handle that sort of thing before you make the transition over to corporate management.

I think the change-over that occurred in selecting a single contractor for the Space Station program revealed many of the problems, and we went through a lot of that kind of exercise when we made that transition. It seems to have been done successfully. And hopefully we can do the same kind of thing with the Shuttle, because the Shuttle is much better defined than the Space Station is. It should, in effect, be easier.

Senator BURNS. OK.

All of us serve on way too many committees in this Senate to really make our rounds. And we are joined today with Senator Kay Bailey Hutchison from Texas. She has accused me of trying to move Johnson Space Center to Montana, but that is not a fair characterization here.

But thank you for joining us today. If you have an opening statement, we will make that a part of the record. If you have some questions, why, we would appreciate that, too.

Thanks for coming.

STATEMENT OF SENATOR HUTCHISON

Senator HUTCHISON. Well, thank you, Mr. Chairman.

I am afraid that there is a lot of competition for moving the missions from JSC to lots of other places, and I am hoping very much that none of that happens. But if it does, I will certainly consider Montana in my first range of options.

Seriously, before we go on, I would like to know if you have asked the other members of the panel how they feel.

Senator BURNS. I have not. I was allowing the statements first. But I just wanted to ask that one question.

Senator HUTCHISON. OK. Well, maybe we should go ahead and let the others finish their opening statements.

Senator BURNS. OK. That is fine.

Senator HUTCHISON. But then I would like to have Dr. Littles' opinion of the one-manager approach and the Kraft report on the privatization. So we will come back to that, though, I guess, after the others have made their opening statements.

Senator BURNS. OK.

Dr. Paul Johnstone, I will just go right now to the list. Dr. Johnstone, who is Deputy Chairman of NASA's Aerospace Safety and Advisory Panel. So we are ready for your—you can summarize or do however you like. And thank you for coming this morning.

STATEMENT OF PAUL JOHNSTONE, CHAIRMAN OF THE NASA AEROSPACE SAFETY ADVISORY PANEL

Mr. JOHNSTONE. Thank you, Mr. Chairman. I guess the first thing I had better do is advise you your list is a little bit out of date. I have not made the glorious rank of doctor. I am plain mister.

Senator BURNS. Oh, OK.

Mr. JOHNSTONE. I thank you for the promotion anyway.

I also, as of March 23, am the Chairman of the Aerospace Safety Advisory Panel, not the deputy. I was deputy last year.

Senator BURNS. OK.

Mr. JOHNSTONE. I think you can offer your condolences for that. [Laughter.]

Mr. JOHNSTONE. The panel was established by Congress after the Apollo Command and Service Module fire in January 1967. We like to think of ourselves as an independent panel. We have nine members, no more than four of which can be ex or current NASA employees. We use consultants as we need them for specific expertise.

We review, evaluate and advise NASA management on those program activities, system procedures and management policies that may contribute to risk. And when you get into management polices that contribute to risk, you are in a big gray area.

Our findings culminate in an annual report, and the 1995 issue was distributed on March 23 of this year. As far as space flight is concerned, NASA has been reevaluating and, I might add, doing a very good job with the tight controls instituted after the Challenger accident.

Many of us in aerospace, who were not associated with the space program, looked at those controls and thought they had gone way overboard, probably rightly so under the circumstances at the time.

But it is now time to look back at that and eliminate as many of the unnecessary duplicate programs as you possibly can.

Structured surveillance developed at Kennedy Space Center is an outgrowth of that process. It has been used in the airline industry for 20 years or more, and it seems to be very successful as more and more of the responsibility for quality is placed where it belongs, with the technician.

You cannot inspect quality into a product. And it becomes more and more important for the SR and QA function to remain independent within NASA.

We find in our visits to the various stations that NASA continues to exhibit a very high regard for safety, and the dedication of the employees to the space program remains high. And it is a good thing that they do have that dedication, which I will explain a little bit later.

NASA, and specifically the Shuttle program, have done a good job of eliminating organizational overlaps, obsolete tasks, and requirements that are no longer valid. The effect of continued reduction leads to uncertainty and turmoil.

And turmoil bothers me, because the only thing that protects you in a turbulent situation is the dedication of the employees. And if you lose that dedication, you are heading for trouble.

Morale is diminished. There is no question about it. Further deep cuts have the potential of increasing the risk of flight to marginal levels.

A period of stability would permit NASA to assess what organization changes, processes, tasks, et cetera, could be safely eliminated, thus enabling further reductions. In other words, we need a rifle shot, as opposed to a shotgun approach.

Shuttle operations: The Shuttle will never be an airline. There is no way, shape or form that it can be. Any reorganization effecting Shuttle operations must be done with great care and recognition that NASA, I think, will always maintain an oversight role

and bear the ultimate responsibility for new system designs. I think it is too late for NASA to get rid of that responsibility.

The Aerospace Safety Advisory Panel has established a special task team to monitor NASA realignment and Shuttle implementation of work force reductions. Through all of this,

NASA must maintain the policy that safety is always first and schedule is second.

Thank you, Mr. Chairman.

Senator BURNS. Thank you, Mr. Johnstone.

[The prepared statement of Mr. Johnstone follows:]

PREPARED STATEMENT OF PAUL M. JOHNSTONE

Mr. Chairman and Distinguished Members of the Subcommittee:

I appreciate this opportunity to appear before you to discuss the Aerospace Safety Advisory Panel's position on the topic of today's hearing. The Aerospace Safety Advisory Panel (ASAP or "Panel ") was established by Congress in the aftermath of the Apollo Command and Service Module fire which occurred at Kennedy Space Center (KSC) in January 1967. Congress enacted legislation to establish the Panel as an independent senior advisory committee to NASA. The Panel is comprised of nine members, plus consultants as needed, no more than four of whom can be present or former NASA employees and all of whom are experts in various fields of aviation and space. Pursuant to carrying out its statutory duties, the Panel reviews, evaluates and advises NASA management on those program activities, system procedures, and management policies that contribute to risk and impact safety. Priority is given to those programs that involve the safety of human flight. The work of the Panel is continuous throughout the year. We conduct upwards of 50 fact-finding sessions each year, using small groups from the Panel to explore areas within their expertise. Historically the Panel has been given unlimited scope in looking into NASA's activities with an eye toward both ground/flight safety, as well as mission success. The Panel's findings, conclusions and recommendations culminate each year in the publication of its Annual Report. This year's report was released on March 23, 1995, and made available to the members of appropriate House and Senate Committees and Subcommittees, NASA and contractor senior management, and the general public following our meeting with the NASA Administrator. The NASA Administrator, his senior staff and NASA contractors look upon the Panel as an independent and separate means to assure that program strengths are maintained and weaknesses are quickly identified and resolved. In the past, Congress has stated that the Panel provides an independent set of eyes and ears to assure them of proper attention by NASA to critical program areas. The Panel's activities provide an opportunity for both the management and "hands-on" personnel to take another look at those areas for which they are responsible. Finally, the Panel does not supplant any of the safety, reliability and quality assurance organizations throughout NASA and its many contractors, nor does it interfere with their day-to-day activities. The Panel does provide independent objective assessments and advice to NASA/contractor management, with emphasis on safety, that is not obtainable in any other way.

The Challenger accident brought into sharp focus the risks involved in Human Space Flight and the importance of risk reduction and management of safety. The Rogers Commission made a significant number of recommendations following the accident, all of which were implemented by NASA. As a result, all procedures and inspections were revised and readapted to the new requirements, thus leading to the considerably larger work-force required to support a Shuttle mission. A sizable effort has recently been expended to reexamine all these procedures and workload increases. As part of this reexamination, Structured Surveillance was introduced at KSC. The goal was to eliminate unnecessary work and inspections in non-critical areas by empowering the technician performing the work with the direct responsibility for quality of the work he or she performs. Inspections have been eliminated, reduced or combined, especially where another inspection occurs later in the work process. This has provided for greater efficiency, increased the pride of ownership among technicians and reduced manpower requirements. Safety is maintained by auditing of the process by quality assurance personnel. This procedure is now beginning to be utilized in other areas as the inspectors and technicians gain experience in its application. The gradual introduction of this process was carefully planned and implemented. Thus far there are no indications of any degradation in the quality of work. It should be noted that a process very similar to Structured Surveillance has been in effect in the air transport industry for over twenty years.

The Panel believes that NASA continues to exhibit an increased safety consciousness in all its activities. The Panel is particularly pleased that our recommendations concerning the enhancements and modifications to the Space Shuttle Main Engine are now being incorporated. We stress, however, that research programs which expand operational limits and involve human flight, whether in space or within the atmosphere, are inherently hazardous. It is imperative that NASA continue its quest for increased safety in its activities. Safety and independent oversight functions cannot be allowed to become "routine" or buried beneath other organizational units. It is vital that as NASA continues to expand its explorations into the unknown beyond the limits of current experience, it does so with continued dedication to risk reduction and risk management that does not hamper critical research and development ventures.

Over the past year, NASA programs have made significant progress despite the pressures of smaller budgets, tight schedules and the loss of experienced personnel in critical positions. Nevertheless, the possible impact on safety as a result of the recent severe budget reductions and the departure of key personnel due to downsizing and buy-outs, particularly in critical programs such as Space Shuttle and International Space Station, continue to warrant the Panel's attention and concern. Recent reorganization and reductions in the work-force have led to turmoil, uncertainty and potential morale problems among the NASA and contractor personnel. The Panel is particularly concerned about the latest proposal for the Shuttle program to suffer even more cuts in resources in the near future. Further erosion of the NASA budget has the potential of increasing the risk of flight to unacceptable levels.

The Panel was recently briefed on the Space Shuttle Functional Workforce Review and was encouraged by the results. The program has been able to identify reductions which have helped to eliminate organizational overlaps, obsolete tasks and requirements that are no longer needed. So far these reductions have not created any unacceptable safety gaps, although schedule flexibility has been compromised in some areas. However, without standing back and assessing the effects of these previous cutbacks, there is a real danger that further across-the-board reductions, without regard to where they are taken or how fast they are implemented, will lead to a less than desirable situation. As long as there is turmoil, it is impossible to clearly define at what point you cross over from safe to unsafe conditions. Certainly one has to be concerned that the program is once again targeted for such a large hit after having experienced significant reductions over the past two years. The Panel is concerned at the overall effect that uncertainty and turmoil is having on the people (the overwhelming majority of whom are contractor employees) who build, assemble, prepare, process and operate the Space Shuttle systems.

The Shuttle will never be able to be operated like an airline, even though this is the impression that is sometimes portrayed. It should be possible to back away from many of the multiple inspections and reviews, but it will never be totally possible for NASA to give up its responsibilities of oversight and contract management. If NASA decides to place Space Shuttle operations at Kennedy Space Center under a single commercial entity, then NASA and the contractor must clearly define the roles and responsibilities of the operator. The contractor must then be held fully accountable to the specified terms and conditions. One major question will always remain, "If NASA is the Shuttle customer, then who will be held responsible to the public for the performance of a mission, let alone a failure?". The question of indemnification under a contractor operated shuttle system is extremely complicated. The Congress has expressed loudly and clearly its opposition to indemnifying certain other government contractors. How then would it ever justify indemnifying a single Shuttle operations contractor against a potential national disaster?

We have recently established a task team composed of experts from the Panel who will be assessing the effects of a reduced work force at KSC and the reorganization of Shuttle-related responsibilities within the Human Space Flight program. One immediate impact of reduction in resources has been the reduction in the number of Shuttle flights per year from eight to seven. However, with the importance of the joint U.S./Russian missions and the beginning of the Space Station assembly process, this does not necessarily relieve any pressure on the schedule. We continue to believe that NASA must maintain the philosophy of Safety First, Schedule Second. If it does, and NASA approaches the reductions presently planned with care and deliberation, executed from an understood and well-established baseline, then I believe that a successful transition can be safely accomplished over the next two to five years. Of course, any reduction in the number of Shuttle flights will have effects on other programs, such as the Space Station and scientific missions. Therefore, a full reexamination of these programs will also need to be made. But most importantly, NASA must be allowed to achieve a point of stability before further reduc-

tions in resources are contemplated. If deep decreases in the NASA budget continue, then we can expect that NASA will no longer be preeminent in research, technology, space exploration and aeronautics, and the U.S. aerospace industry will cease to be a leader in aerospace technology in the next century.

That concludes my prepared statement. I would be pleased to answer any questions or discuss any matters that may be of interest to the members of the Subcommittee.

Senator BURNS. And I am sorry about the doctor business, but, you know, they asked me the other day—after my name I have NDBA, and the guy asked me what that was.

And I said, "No degree but boss anyway."

So we just operate under that premise. [Laughter.]

Senator BURNS. Now I am right, though. Dr. Logsdon, thank you very much for coming this morning. We will hear your testimony now.

STATEMENT OF DR. JOHN M. LOGSDON, DIRECTOR OF THE SPACE POLICY INSTITUTE AT GEORGE WASHINGTON UNIVERSITY

Dr. LOGSDON. Thank you, Mr. Chairman.

I think the main asset of having a Ph.D. is that it lowers the likelihood of a decent salary in life. But so it goes. [Laughter.]

Dr. LOGSDON. I just want to make a few summary remarks from my written testimony. The only thing I would like to correct on the written testimony is the date of this heaving, which I put as May 17. I wrote this Sunday night straight off of a 12-hour plane flight, and I guess I was not sure what day I was in.

I once described the Shuttle program as a policy failure, in the sense that it had not provided the reliable, low-cost access to space promised, and also in the sense that the United States had made a major policy mistake in placing total dependence on the Shuttle for its access to space.

I would use the same words, "policy failure," today to describe the recent past, but for slightly reasons, and I would extend the comment to our space transportation policy in general.

We know how to launch the Shuttle and how to exploit its capabilities, but it costs too much, particularly in an era of declining budgets. And it limits what else we can do in space.

We are no longer totally dependent on the Shuttle for access to space, but we are dependent on it if the Station program is to be viable.

By the necessity of focusing so much of its attention on operating the Shuttle safely, NASA has lost too much of its cutting edge research and development focus.

I think our biggest failure, though, is that 23 years after the approval of Shuttle development, the United States still has not begun to develop next generation transportation systems.

By my calculations, by 23 years after the beginning of the flight of the DC–3, we were flying 707s, with a number of systems in between.

It seems to me that the transportation policy put out by the White House last August is a reasonable approach to addressing our failures in space transportation policy, and so by and large I would urge that it be embraced by this Congress.

Refocusing NASA's efforts on reducing technological risks is particularly essential. The United States has lost two decades of launch-related R&D while Europe, Japan and Russia have developed and are putting into operation modern launchers.

If we are going to be a leading spacefaring nation, we must address the space launch issue. It seems to me, and I agree with Dr. Grey and, of course, Dr. Mansfield, that both the X–33 and X–34 programs are steps in the right direction.

Their emphasis on reusability is important.

I think the Shuttle program went awry when reusability got mixed up with design compromises to satisfy multiple users on one hand and designing it to a very limited budget on the other.

I hope we can avoid repeating that experience and resisting the temptation to try to make a single system all things to all people.

Clearly, it is important to find a way to operate the Shuttle safely, reliably and as cheaply as possible. Whether that is a single prime contractor or some other entity is a bit beyond my competence. It seems to me that the judgment of people as experienced as those on the Kraft Committee should not be challenged very lightly, though.

We know how to operate the Shuttle. It is a mature system. And it seems to me that we can develop a management structure with appropriate government oversight and responsibility different than the rather complex structure that exists today.

We have to do that, because we have to use the Shuttle for at least the next 10 to 15 years.

Next January, it will be 10 years since the Challenger accident. We have given, properly, a lot of attention to making sure there is no repetition of the factors that contributed to that accident. And that attention cannot be diminished.

But we know how to operate the Shuttle with appropriate margins of safety, not margins that exceed what is reasonable.

Of course, that is easy to say in advance of another Shuttle accident. What is also needed is political support and understanding that accidents are a fact of life in using complex technologies. Hopefully, any subsequent Shuttle accident, and there is, at least statistically, likely to be one, will not be as catastrophic as Challenger.

It is becoming almost a cliche to say that the United States is at a critical transition point in its civilian space activities, but the observation is accurate nonetheless.

Getting our space transportation policy on a sound basis is essential if that transition is going to lead to a stable and productive future.

Thank you.

Senator BURNS. Thank you.

[The prepared statement of Dr. Logsdon follows:]

PREPARED STATEMENT OF JOHN M. LOGSDON

On January 5, 1972, President Richard Nixon announced that he had approved NASA's request to develop a new space transportation system—the space shuttle. This decision has had profound consequences for the United States space program for the past two decades, and its impacts will be felt for at least another ten years. The issues before this committee today are just one manifestation of the centrality of the space shuttle to U.S. space policy and programs.

It is important at the outset to recognize that the shuttle continues to be a major technological success as a first-generation, partially reusable spaceship that gives this country unequaled flexibility and capability in its space operations. And, with the International Space Station program on the near-term horizon, the shuttle will finally assume its role when first conceived—as a transportation system for people and supplies to and from a permanent outpost-in space. In addition, of course, a, main reason why the shuttle payload bay is the width it is was NASA's 1970 recognition that, with the final shutdown of the Saturn V production line, the shuttle would have to be used to assemble the station, not just serve as its logistic vehicle. I once described the shuttle program as a "policy failure," in the sense that it had not provided reliable, low-cost access to space, and also in the sense that the United States had made a major policy mistake in placing total dependence on the shuttle for its access to space. I would use somewhat the same characterization today to describe the recent past, but for slightly different reasons. And I would extend it to our space transportation policy in general. We clearly know how to launch the shuttle regularly, and how to exploit its many capabilities. But the cost of using the shuttle still limits what we do in space, particularly in an era of declining NASA budgets. We are no longer totally dependent on the shuttle for access to space -but we are dependent on its availability if the station program is to be viable. By the necessity of focusing so much of its attention on operating the shuttle safely and reliably, NASA has lost too much of its focus on cutting edge research and development. Our biggest failure, however, is that twenty-three years after approval for shuttle development, the United States still has not begun to develop a next-generation transportation system. (By contrast, the Boeing 707 had entered service twenty three years after the first flight of the DC-3!)

The National Space Transportation Policy issued by the White House last August seems to me a reasonable approach to addressing our failures in space transportation policy. Refocusing NASA's efforts on reducing the technological risks associated with next generation space launch systems is particularly essential. The United States has lost two decades of launch-related R&D, while Europe, Japan, and Russia have developed and are putting into operation modern launchers. If the United States is to remain a leading spacefaring nation, it must address the space launch issue. Both the X-33 and the X-34 programs appear to me to be steps in the right direction. Those that first proposed the shuttle were correct in their emphasis on the necessity of reusability; the program went awry when it was compromised to serve too many purposes within an inadequate budget. We should not repeat that experience.

I am not really competent to judge whether shuttle operations should be taken out of NASA. But it is certain that a repetitive activity such as shuttle processing does not require the same skills as developing the technologies and systems that will go into a new launch system. What is important is keeping those two activities separate, and making sure that the shuttle continues to operate regularly and safely even as new launchers come on-line. It was a major mistake to plan on phasing out ELVs as soon as the shuttle was (prematurely) declared operational; we should not repeat that mistake as new systems become available. This means that we should develop an approach to shuttle operations that can remain effective and affordable for at least 10-15 years.

Next January will mark the tenth anniversary of the *Challenger* accident. We have given, properly, a great deal of attention to making sure that there is no repetition of the factors that contributed to that accident. Given the continued central role that the shuttle will play in the next decade, that attention cannot be diminished - but by now we ? to know how to operate the shuttle with appropriate margins of safety, not margins that exceed what is reasonable. Of course, this is easy counsel in advance of another shuttle accident; what is needed is political support that recognizes that accidents (hopefully not nearly as catastrophic as Challenger) are a fact of life in using complex technologies. The record suggests that we were taking unnecessary risks in the first twenty-five shuttle launches; we cannot eliminate risks, but certainly must continue to find a way to keep them to a minimum.

It is becoming almost a cliche to note that the United States is a critical transition point in its civilian space program - but the observation is accurate. Getting our space transportation policy on a sound basis is essential if that transition is to lead to a productive, stable future.

[The biography brief provided by Dr. Logsdon can be reference in subcommittee files.]

Senator BURNS. Dr. Littles, the fiscal year 1996 budget request for the Space Shuttle program is $3.23 billion. That is an increase of 2 percent over the 1995 funding level. When we are talking

about cutting back and everything, did you want to make your case for that?

Dr. LITTLES. Well, the small change, 2 percent, in the budget between those 2 years is not significant, I do not think, in terms of what we are doing. The Shuttle budget is broken into a large number of line items where the cost varies from year to year depending on what the activities are.

If you look at the breakdown of those line items in the budget between those 2 years, I think you would see that there is some increase in the activities that are supporting performance upgrades. And that is just because of different projects coming on line and going away.

So there is nothing major in there that reflects that small increase. And, of course, that small increase is less than inflation, as well. So it does not represent a new initiative or a change.

It is just a carrying on of activities that have been defined, and the funding levels are fluctuating slightly.

Senator BURNS. We know of your cutbacks from the $4 billion to $3.1 billion. We also know your cutbacks of 6,000 almost in personnel. And yet you have maintained your normal flight levels and really have done an exemplary job, I think, anyway, in completing your mission.

In your words, give us some idea on how you did this, what philosophy you approached with these cutbacks, and give us some kind of a blueprint of where do you think we go from here in order to carry out missions and yet maybe have to do it with less money.

Dr. LITTLES. Well, I think the program, as you recognized early, has done a really fantastic job in being able to economize between 1992 and 1996, which were the years that we quoted.

When I came into the program, I reviewed in detail what has gone on there. And of course we have had, as I mentioned earlier, and you are aware, we have had reviews to look at that, to make sure that there has been nothing done there to compromise safety. And the reviews have verified that.

Fundamentally, those changes during that period of time fall into two categories. About half of that $1 billion is content that was taken out of the program. One significant piece of that was the Advanced Solid Rocket Motor, which amounted to something over $300 million per year. So that is one significant reduction.

The program has also cutback significantly on what it thought it might need in terms of facilities budget. And there were some other content that were taken out of the program.

And the program has also, over that period of time, taken about half of that savings in changing and improving the way it does business, adding efficiencies.

And, frankly, some of those savings, a significant part of them, have been gained by looking at the work force and looking at the tasks that were being done and making decisions as to whether those tasks should continue to be done.

There are a number of examples of that. When I was not on the program—three years ago, I was Deputy Director at Marshall. And we reviewed some of our major programs. And we found significant savings by going and looking at the detail of what was being done and deciding not to do some things.

Frankly, we had some of our contracts set up—they were doing what we asked them to do. There was no malice. But we had them doing things that we did not need where the program stood at that point in time. So we have cut significant amounts of money out, and that has been done in other places.

Senator BURNS. You called for—you have $800 million unresolved cuts over the next 5 years in your 5-year budget. Have you made any progress on where those cuts are going to come from?

Dr. LITTLES. We are making significant progress on that.

The unresolved that was in the 1995 budget for the 1996 year for the Shuttle was something over $500 million. I think it was about $550 million, as I recall.

By the time we submitted the 1996 budget to Congress, that unresolved had been reduced down to about $290 million. And these are round numbers, but is about that.

We are continuing to look at that unresolved as we are involved now and looking forward to the 1997 budget. I reviewed the status of the program with regard to that unresolved, as well as everything else they are doing, just this week. That number in 1996 is down now to between $50 million and $60 million.

Now, one thing, though, let me be quick to add, the number of—the amount of money in unresolved in the outyears was about that same level as we went into the 1996 budget.

What we are doing now, looking at efficiencies, cutting out content, reducing work force where we can, it is looking as though, as I mentioned in my opening statement, that we will be able to manage that unresolved. I am beginning to feel confident we can do that.

I am a little bit concerned, though, at some of the things I read in the press about significant major additional reductions to the Shuttle program. We are still doing some things, defining some activities.

And a part of that is going to come from this restructuring that was recommended by the Kraft Committee, and we fully support that.

There are going to be some efficiencies and savings that will come out of that that will help us resolve the outyears between now and the year 2000.

So we have a lot on our plate. We are not going to do anything that is going to compromise safety. We will review every action we take to make sure that it does not, but we have a challenge in front of us.

Senator BURNS. Senator Hutchison.

Senator HUTCHISON. Thank you, Mr. Chairman.

Unfortunately, I suppose, the potential white paper that you have been working on, Dr. Littles, somehow got into the public arena. I hope that it was premature, because there is a great concern about some of the things that were being looked at.

I would like for you to speak to where you are on that and the idea of first taking the step to put all of the management functions under one head, which would indicate that we are getting efficiencies, and then a recommendation to split off engineering functions from JSC partly to Marshall, partly to Florida, which does

not seem to go along the lines of efficiencies and integrated products.

So I would like for you to talk about that this morning and tell me where you are.

Dr. LITTLES. OK. Let me try to separate some activities that are going on. You mentioned the white paper. When that white paper was put together, it was done by a few people. I was not a member of that group, by the way.

There were a large number of ideas that were listed in that paper, compiled from a lot of things that had been looked over the years.

There have been studies within the Shuttle program of changing management structure a number of times over the years. So there were some of those kind of things that got into that paper.

There was a team formed headed up by Dick Wisniewski and a lot of people at the Deputy level and others within the agency. I went and looked at all the content of the things that were in that white paper, and I also looked at, beyond that, roles and missions between centers.

That team, as you know, has essentially completed its work and is in the process now, I think, of getting ready to report out.

In some preliminary information that somehow got into the media, there were some statements relative to—I think one of them specifically was mentioned by Dr. Grey—a transfer of the Shuttle management to KSC.

Now, frankly, that is an element that is a decision that has to be included in the total process that we within the program and the Center Directors are looking at to realign and restructure the program.

There has been no decision. As a matter of fact, that particular item is not even within my sights yet.

What we are looking at right now is the specific recommendations that came out of Dr. Kraft's team in his report that relate to the restructuring of the program and fundamentally changing the way the government work force does work and relates to the contractors that are doing work.

There are several key things in that. First of all, you will notice that Dr. Kraft recommended that for those portions of the Shuttle program which are operational, and there is a significant amount of the program which now is operational, in that there are routine functions being performed at the Cape and at JSC, where he recommends that fundamentally those be taken over by a contractor and the government work force back out of that and go do R&D-type work.

So that is one——

Senator HUTCHISON. Could I interrupt you there——

Dr. LITTLES. Sure.

Senator HUTCHISON [continuing]. And ask: Do you support the privatization as in the Kraft report?

Dr. LITTLES. Dr. Kraft recommends that we go basically to a prime contractor, and he studied three different options,

I think.

And then in his recommendation—I think it is his last recommendation—he recommends that as that management concept matures and develops, that we consider privatization.

So the way I am looking at this, the way the program is looking at it, is the restructuring we are beginning to understand and are planning to do is a first step toward an eventual privatization, if the decision is made to do that.

There are actually two separate things. As we move forward to restructure the program, we will posture ourselves and will posture industry into a position where that could be done.

Senator HUTCHISON. So you support the first step, which would be a prime contractor concept, then leaving options open for the future for privatization or not.

Dr. LITTLES. Yes. We do support the consolidation of contractors. Now one of the things that we are still looking at is the exact structure of that.

And the reason we are still looking at it, frankly, is that there is another activity that also came out of the Zero——

Base and the Roles and Missions.

Senator BURNS. Just a moment. [Pause.]

Senator HUTCHISON. I wanted to follow-up one thing with him.

Senator BURNS. OK. That is good.

Senator HUTCHISON. And then if we are—and then I will go back to you, and then I will want to come back if that is OK.

Senator BURNS. OK.

Senator HUTCHISON. Thank you.

Dr. LITTLES. And that item was a recommendation that mission operations be consolidated across the agency. And that is basically work at Johnson, at Goddard, at JPL and some other smaller things.

But there was a recommendation that it also be consolidated across the agency. There is a team, that is led by John O'Neil at JSC, that is looking at that. And we have to understand their conclusions before we can establish the final structure of Shuttle consolidation, because mission operations is a part of that.

If you set that aside, then yes, we fully support the consolidation of contractors As a matter of fact, we think we are going to get savings out of that. However, I believe that most of the savings we are going to get are going to come from the backing off of the government work force.

Dr. Kraft recommended a very thorough look at our requirements, and we are in the process of doing that. We are going to get some savings there. He recommended that we completely relook at the way we are doing our safety functions.

There are a lot of things that were put in the program after the Challenger that we need to re-look at. The way we fundamentally relate our safety activities to the hardware manufacturing in plans, we are looking to that.

So we fundamentally support all those things, but there is a lot of work to be done to understand the details of what they mean and how you structure that and consolidate the contracts into what might be a single prime.

One of the things, and I think someone mentioned a minute ago, related to the Space Station consolidation and change in manage-

ment to Shuttle, actually in my opinion, Space Station in a lot of respects was easier because there were a significantly fewer number of contracts.

We have a total of 85 contracts, which in one way or another are working on the Shuttle. Now a lot of those are small, but there are almost 25 of those—I think the number is 23. I counted them the other day—that are more than $25 million.

Understanding how you consolidate all that and integrate it and make sure that you do not lose work that has to be done is something we have to study very carefully.

Senator HUTCHISON. Dr. Littles, I want to follow up, because you covered a lot of points. And I really want to focus on this, but I know I am really over time.

Mr. Chairman, if you would indulge me?

Senator BURNS. You are so over time—we have a vote on now. Are we both going to go vote and just come back, or did you want to pursue your point, and I will go vote and then maybe you can go vote?

And if you do not think you can make it, you can recess, and I will come back. How would you like to do this, Senator?

Senator HUTCHISON. Well, I am very interested——

Senator BURNS. I am out of the——

Senator HUTCHISON [continuing]. In this.

Senator BURNS [continuing]. Decision-making process here.

Senator HUTCHISON. So I would like maybe for us to go vote and then come back because I would like to be able to focus on this, and I would like to be able to focus on this particular issue without going into reinventing the wheel, because I am very concerned about the direction we go. So if we can go vote and come back——

Senator BURNS. The Senator makes a point, and we will just stand in recess. We will go over and vote, and we will be back. We hope to be back in about 15 minutes. And we thank you for your patience. [Recess.]

Senator BURNS. I will bring the committee into session.

Thank you for allowing us to do that.

I am going to allow Senator Hutchison to pursue her line of questioning with Dr. Littles when she arrives back.

In the meantime, Dr. Mansfield, I have a couple of questions for you.

By the way, we are going to leave the record open. We might, if I might suggest, submit some questions to you, and you can reply to the committee and to the individual senator, because some senators—it is just like I say; we serve on too many committees. We are jumping.

And I know that Senator Rockefeller and those who serve on this committee are as interested in this project as you are, but you have to kind of set priorities.

Dr. Mansfield, I have a question for you, and then we will go right back to Senator Hutchison's line of questioning.

The 1996 budget request includes $159 million for a new reusable, the RLV program, of which $49 million is for the X–33 program.

In NASA's responses to our post-hearing questions relating to our March 1st oversight hearing, NASA agreed that the RLV could

cost about $650 million by the end of the decade. Do you agree with those numbers?

Dr. MANSFIELD. Yes, Senator, I do.

Senator BURNS. Any kind of a cutback in that, how much does that slow that down? Give me your impression. If we have cuts in that area, does that slow us down, and how important would that be to the program?

Dr. MANSFIELD. Senator, it would slow us down. The cost, is actually $662 million, I believe, between now and the year 2000, to fly the X–33 vehicle would be increased if we spread it out, and we would probably not be able to fly it before the year 2000, as we had hoped.

It is the year 2000 goal for having this technology data on the table to make a decision on a full-scale vehicle, in order to save money that we would otherwise have to invest in improvements to the shuttle program. So you spend money now to save money later.

Senator BURNS. Senator Hutchison, you may pursue your line of questioning.

Senator HUTCHISON. Yes.

Senator BURNS. Thank you.

Senator HUTCHISON. Thank you, Mr. Chairman.

I wanted to try to get from Dr. Littles where you stand now on the proliferation of the engineering function versus having it where the crew would be.

Dr. LITTLES. Let me try to explain the way I envision changes in the work force when we implement the Kraft recommendation, and that is basically what we are doing.

As I mentioned, one of the key things that the team recommended, Dr. Kraft's team, was that the government work force remove itself from day-to-day operations of the shuttle. We agree with that. We plan to implement it.

What that means is, we have engineers at the Marshall Space Flight Center, at the Kennedy Space Flight Center, and at the Johnson Space Center who are involved right now, today, in operations.

There are contractors who are doing that job as well. We are going to implement the recommendation of the Kraft report, which means that those engineers and people at those three centers who are now involved with operations will turn those activities over to contractors. That is a fundamental recommendation of the Kraft team.

So those activities that are being done will be done by the contractor. We will not be moving engineers around anywhere when we do that. It is just that those jobs that are being done by Civil Service, the Civil Service will back out of those and the contractors will do them. So there is no transfer of work when we do that.

The design centers, the Marshal Space Flight Center and the Johnson Space Center, will still be involved and doing the same work they are doing today relative to development. That is the recommendation in the Kraft report, and we plan to implement it.

Senator HUTCHISON. Well, the Kraft report specifically said that there should not be a separation of spacecraft design from crew and flight management operations.

Dr. LITTLES. I do not believe that was in the Kraft report. I have heard that, but I do not disagree with it. We are still going to have—those engineers at the Johnson Center, who are required to support operations, will still be there.

Those people, by and large, will be contractors, where they are dealing with operations. Where they are dealing with development work that is still being pursued, the development engineers at Johnson and Marshall, who have been doing that work, will continue to do it.

Senator HUTCHISON. All right. So you are saying there is not going to be a mass transfer from JSC of the engineering functions away from the crew operations.

Dr. LITTLES. I do not envision that for Shuttle restructuring. No. Obviously, the operations there, the mission operations division, still has to have the expertise and understanding to support them for the Orbiter systems and subsystems, and that will still be at JSC. It will, though, since it is an operation function, be contractors that are doing that work.

Senator HUTCHISON. All right. I just want to make sure that in your answer there was not something that was a separate function—you know what I am asking, and are you saying directly that you are not seeing a major shift as was in part of the preliminary white paper information? Perhaps it was not recommendations, but it was information.

Dr. LITTLES. That study was not addressing specifically the restructuring of the Shuttle program, but roles and missions between centers.

We have, by the way, developed a set of guidelines for the restructuring we plan to do, which was developed by my management counsel, which includes the center directors for all four centers, and the kinds of changes that I just mentioned to you are included in those guidelines. Everybody agrees with the way we are going.

Now, the thing that you are mentioning was a separate activity that was related to roles and missions. I think when you see the results of that in the next few days, I do not think you will have any concern with that. But that was not related to restructuring of the shuttle program, per se.

Senator HUTCHISON. Is that preliminary information that was released then not appropriate for consideration for the future, or are you telling me that in what will come out in the next few days, you are going to basically have the same functions at JSC, Marshall, and Kennedy?

Dr. LITTLES. I do not—now, let me make sure that I do not mislead. I do not see the same functions associated with the shuttle program.

Again, I see those engineers on the Civil Service side, who have been doing operations work, not doing that any more, but they will not be transferred somewhere else, or some other Civil Service individual will not be doing it. It just will not be done by the government work force.

That is a part of that restructuring, and consolidation, and giving a contractor the responsibility and accountability of doing the job.

But we do not envision saying that work is now done in this location, we will do it somewhere else. It just will not be done.

Senator HUTCHISON. Well, are you saying that the jobs are going to be transferred then from contractors at JSC to contractors in Florida or Alabama?

Dr. LITTLES. I do not know how the restructuring will fall out on the contractor's side. The contractors have not looked at that restructuring in giving us a recommendation.

What I do expect, though, is that there will have to be, if we are going to fully implement and streamline the program,

I think there will have to be changes in the way some of that work is done.

For example, at the present time, and I will use the Orbiter as an example, and I could use other projects as well, at the present time we have four organizations who are responsible for the Orbiter, or aspects of it.

We have the Shuttle Processing Contractor at Kennedy. We have the Civil Service engineering work force at Kennedy. We have Rockwell. And we have Civil Service work force at JSC. All four of those organizations are involved not only in design and development, some of them, but they are all involved in aspects of operation.

Now, if we are going to consolidate this program, focus it, and make it more efficient, that is all going to have to be collapsed so that one entity has the responsibility for that work.

Senator HUTCHISON. Do you foresee moving the engineering function away from the crew operations?

Dr. LITTLES. I do not see any case where there would not be the engineering support that is required to support operations. I think those people will be at JSC. I think they have to be.

And we have to have the expertise there to support mission operations to respond to problems with subsystems or whatever. That work should be there onsite in support of that function, as it is today. But, again, I envision that being predominantly a contractor work force.

Senator HUTCHISON. But you foresee that it is going to be done in the same place.

Dr. LITTLES. I would see no reason to move it. I mean that is where the work is.

Senator HUTCHISON. Well, it is where——

Dr. LITTLES. It is there to support operations.

Senator HUTCHISON [continuing]. The work is, and there is a safety issue, as we learned in Apollo 13, when the astronauts have input.

You cannot have a design function, I do not think, efficiently away from the people who are going to actually operate the shuttle, can you?

Dr. LITTLES. I do not disagree with that.

Senator HUTCHISON. Thank you, Mr. Chairman.

Dr. LITTLES. I think there has been some confusion with words that have been—which did not fully elaborate on what was going on. Now, again——

Senator HUTCHISON. Well, I understand that when information papers are leaked, it does cause unforeseen consequences. I do understand that.

But I am just trying to make sure that you and I are having a straight question and answer session here, because I, obviously, believe that the crew should be where the design is. I think that has been proven.

I think Chris Kraft has spoken very eloquently on that subject, and that did not seem to be the intention of some of the information that was gathered that was in this preliminary unpublished white paper.

Dr. LITTLES. I agree, again, that when there are design changes, when there are design issues with the Orbiter, I would expect that work to be done at JSC.

As a matter of fact, that is clearly stated in our guidelines, that the design center will still be responsible for that work, and as a matter of fact, in order that we have the right amount of hindsight and oversight of operational activities, which are going to be done by the contractors.

But if there are issues and operations that relate to design, some new and normally something that has not been seen before, that also will be looked at by the design organization.

The expertise that is there will look at that new condition, so that they can tell me that I can go fly the next flight.

Senator HUTCHISON. Well, I just hope that you have not said things that I, as a lay person, would not have picked up that would be different from what I am understanding.

Dr. LITTLES. I do not think I have.

Senator HUTCHISON. OK.

Dr. LITTLES. I understand what your concern is, and I do not think I have.

Senator HUTCHISON. All right. Thank you very much.

I thank you for your forbearance, Mr. Chairman.

Senator BURNS. That is quite all right. We thank you for your interest in this.

Dr. Mansfield, let us go back to you just for a second.

I kind of want to get, I guess, a statement from all of you with this, but I will start off with Dr. Mansfield.

Dr. Logsdon has indicated a little bit of criticism that we are just not moving fast enough with our new technologies and the new programs over the next generation of space access, and how we get there.

That criticism I have heard from other sectors, and then you go on home to Montana, and they say, well, why are you supporting something that we are not deriving any benefit from. So you have to understand that to every question there is a political side to this, also.

But even many people who approve of the funding of the new launch vehicle program might question the need of two programs, the X–33 and the X–34.

Would you explain why the two programs are required or needed? And then I would like to get comment upon the criticism that Dr. Logsdon has expressed here and, I would say, not in a critical

way, but in other words, trying, I would say, to influence policy where we may be moving into the next generation.

Dr. MANSFIELD. Senator, the reason for two programs is best understood as follows. The follow-on large reusable launch vehicle requires an "X" vehicle to reduce the risk.

This would be a fairly large vehicle, the X–33, that could be extrapolated to the large vehicle.

That is, you could be sure by flying the X–33 that you have done all the technologies right to be able to do the full-scale vehicle early in the next century.

That vehicle would fly by 1999, in order to enable this decision. We have an opportunity to fly a smaller vehicle sooner that, indeed, demonstrates a number of the technologies that we need to have demonstrated by 1997.

Furthermore, that vehicle, although it would not be an orbital vehicle, could have an upper stage added by the contractor, at his own expense, to make a production launch vehicle out of it. So that would be the X–34.

The X–34 vehicle would allow us to demonstrate reusability, the durability of these composite structures and automatic control mechanisms, and thermal protection systems at the earliest possible date. That data will be very useful for the X–33 program.

So in summary, they are different in scale, one is larger, one is smaller; they are different in time, one is earlier, and one is later, but they are similar in that they demonstrate the technologies needed for the full-scale vehicle.

Senator BURNS. Dr. Logsdon, please.

Dr. LOGSDON. First, I want to clarify that my criticism was criticism of the past 20 years, during which, once we decided to go ahead with the shuttle, we stopped all the rest of our transportation research and development, and put all our eggs in the shuttle basket.

You ask: Why do we need two launch vehicle programs now?

I suspect when you fly home, Senator, you do not fly into Helena, or whenever your home base is, in a 747.

There are two very different purposes served by the X–34 program and what might follow, launching 1,500-pound payloads into space, and the X–33, which will be the workhorse launching 20,000-pound cargo, and eventually putting people into space.

They are just fundamentally different programs. They have synergy between one another, but since we have done nothing for 20 years, I applaud the fact that we are beginning now to do something at both ends of the spectrum.

Senator BURNS. Jerry.

Dr. GREY. There is one other point, too, and that is when we get to conversion of the X–33 technology demonstrator into a full-scale vehicle, which everyone assumes private industry will take up, we are talking about an investment in the $5 billion range, give or take a few billion.

You can test out the whole management, the whole government industry interchange privatization, at a much lower level, at the $70 million level for the government, in the X–34. And a lot of the things we find out in the X–34 may be applied from a management

and financial-structure point of view to the X–33, which is going to be a much bigger and larger vehicle in the future.

So the X–34 is really a pathfinder, I think, for everything that you want to do with the X–33 and beyond.

Senator BURNS. Dr. Littles, do you want to comment on that?

Dr. LITTLES. Well, I agree. I think that both of those programs are needed and useful, and provide benefits.

Dr. MANSFIELD. If I could add one further comment on that, sir?

Senator BURNS. Yes.

Dr. MANSFIELD. Dr. Grey is absolutely right. The total government costs here is limited to a $70 million investment.

The contractor will pay considerably more than that, probably over $100 million for the vehicle itself, and then some amount above that for the second stage required to make it a reusable vehicle—make it a launch vehicle.

What the government gets out of that is the ability to launch satellites for a few million dollars in operation, something we cannot do now at all. So it gives us a capability that is absolutely missing for our light, small satellites.

Senator BURNS. NASA is responsible for reusable launch technologies; the Department of Defense is charged with upgrading our current fleet of expendable launch vehicles.

I would ask—and I think probably we might have a mind- set coming in here.

We have two different approaches to it, I guess, where both of us are going, "Why is DOD looking at maintaining and upgrading the existing launch assets while NASA was seeking to develop new vehicles? Does that just tend to slow things down?"

Dr. MANSFIELD. Not really, sir. DOD has near-term requirements for National Security payloads that require it to be ready to field follow-on to an Atlas program that will be over 40 years old, a Titan program that will be 40 years old, and a Delta program that will be almost that old.

In fact, the Delta is even older than that. So it has requirements for follow-ons to be ready to replace an aging and expensive expendable launch vehicle fleet for its own national security payloads.

We fully expect that the DOD will want to launch satellites on the reusable launch vehicle when it is ready and proven, but until that time, it is entirely appropriate that they invest on an expendable vehicle fall-back.

Dr. GREY. Another major point, and this is Dr. Logsdon's point, we do not want to put all our eggs in one basket again.

We have an existing fleet. That fleet is operating fairly well, but it is expensive, like the shuttle.

The purpose of the Air Force program, in part, is to reduce the costs and improve the operations of the existing fleet, without going to a whole new vehicle, by making a relatively small investment, whose return will come in the form of reduced cost for launches over a period of years.

So, again, what Dr. Mansfield says is correct, but the other point, that we need to maintain a fairly broad spectrum of launch vehicles can meet national needs still remains, and Dr. Logsdon's point is well made.

Senator BURNS. Dr. Littles, NASA is considering reducing costs by eliminating unnecessary safety-related requirements for the shuttle.

Would you discuss for us, in layman's terms, so I can understand that, what some of those requirements are right now that you would eliminate, and why you are doing so? I think there are still some safety concerns.

Dr. LITTLES. Well, as I mentioned earlier, we are looking at the way we do some of our safety activities and other oversight activities within the program. Let me just mention a couple of things as examples.

We have questioned for some time whether the number of inspections that we do, what we refer to as government mandatory inspections, are required.

What that is, is a technician basically does a job, and he stamps that he has done it.

And then there is a contractor inspector who inspects that, and he says, "OK, he did it."

And then we have a requirement for a government inspector to come behind those two individuals and verify that it has been done.

We have a large number of those kind of inspections in the program. At one point in time, when I did review in the external tank about 3 years ago, I think we had 15,000.

That has now been reduced to about 4,000, and there are a large number of across the program, and we are questioning whether we need to do that.

Senator BURNS. Do you mean 15,000 people who were just in the inspection business?

Dr. LITTLES. That was 15,000 inspections, not people.

Senator BURNS. Oh.

Dr. LITTLES. Inspections. OK? Now, there have been instances, a number of instances, where we have found that adding inspections was not beneficial, and as a matter of fact, detracted from the accountability and responsibility of those primary people who were doing the job.

So we are re-looking at that, and I expect one of the things that will come out of that will be some reduction in that activity.

We have currently in the program areas where we require multiple organizations to verify that work has been done.

There are times when we have eight or ten different organizations who have had to sign a piece of paper to say that work had been done, when those organizations were not even responsible for the work.

It is checks and balances, but it is checks and balances to the extreme. We are re-looking at those things, and I fully expect that some of those activities will be deleted, and we will very clearly specify who is responsible and accountable for those activities.

So there are things like that that we are re-looking at. The relook is being done, as a matter of fact, by Fred Gregory and the Safety and Mission Assurance Organization, in conjunction with the program and the projects, and I fully expect that coming out of that we are going to have a safer program than we have now.

Senator BURNS. Mr. Johnstone, do you have any comment on that, being that that is right down your line of expertise here?

Mr. JOHNSTONE. Well, I do not know, but it has been done in the airline industry for a long time. I would recommend the process very highly, and I think Wayne is not quite owning up to the fact that they have a real good start on that in structured surveillance at KSC——

Dr. LITTLES. Yes, we are moving in that direction.

Mr. JOHNSTONE [continuing]. And that is the principle that we are talking about. The only way you can put quality into a product is to build it in.

And you can have inspections on top of inspections, but if the guy did not build it right in the first place, odds are one of them is going to slip through.

As a result of the Challenger, there were layers upon layers of inspections, and as Wayne said, in one area alone, 15,000. That takes a long time to go through every one of those and say can I eliminate this inspection without compromising safety.

It takes a good study to go after it and do it. It is going to take time to do it. This is where I say you can reduce further by using a rifle, not a shotgun. They have to go after every one of those inspections and decide which ones are needed and which ones are not.

Senator BURNS. I want to offer a comment here, because, as you know, in the news this week has been the delivery of the Boeing 777. I had an opportunity to go to Evergreen and their facility of assembling that airplane.

This will be the first airplane that has been designed by computer that no mockup or prototype was built before the airplane went into manufacturing.

By the way, I have to brag a little bit, because the lead engineer on that was—his folks still own a ranch, and the ranch is up around Montana.

By the way, the man who is in charge of manufacturing assembly is a wheat farmer from Chester, Montana. So we are going to call this the Montana airplane, if it works. Now, we are not going to say it if it does not work. [Laughter.]

Senator BURNS. But I would say that NASA has to be watching things like this in its design and manufacturing, because I think this is an important step. This airplane really sends a loud message, if those of us are listening, is that correct?

Mr. JOHNSTONE. Well, I think it is correct, as far as the design and the manufacture is concerned. I have not heard anybody say that that is going to decrease the operating costs of the airlines very much.

Sure, if the airplane is built better in the first place, the airline is going to have less to worry about, but he still has to operate it, and Boeing is not going to be the operator of the 777. NASA is the operator of the shuttle, at the moment.

Senator BURNS. Is there any other comment then? I want to go to Senator Hutchison for another question.

Senator Senator Hutchison. Let me just first comment and say that I think Mr. Johnstone's remarks make it even more apparent that you need the crew and the management in the same place as the design.

If the thing is not designed correctly, or it is not built right, all the inspections in the world are not going to help. I think that having the crew and the design team together every step of the way must be common sense.

Mr. JOHNSTONE. Well, I think that the broad statement is yes, they must be involved in the process. I can assure you that United Airlines undoubtedly has a flock of test pilots, a flock of engineers, everybody in residence at the moment up in Seattle watching over Boeing's shoulder. All airlines do that.

Once the airplane is delivered, however, pilots and engineering, or crew and engineering are still together, but those pilots that are involved are not necessarily the ones that are flying the airplane all the time.

You can keep them together without having them—you probably will not like it, but you can keep them altogether, but maybe not in Houston.

Senator HUTCHISON. Well, I do not think that is an option at all. [Laughter.]

Mr. JOHNSTONE. I think it is a matter of how you support during the design and development stage, and where they are in residence during that stage I am not sure is all that important.

It can be done without them being physically in residence. I spent a lot of time going back and forth to Boeing over the years, but we still kept an eye on them.

Senator HUTCHISON. Well, we would differ on that, frankly. I have not seen any argument, whatsoever, in which it makes sense to transfer your engineering functions away from the home base of your crew, and I think it has been shown in the past that it does make a difference. And I think your point really spoke to that originally.

Mr. JOHNSTONE. I think what we are talking about is the difference between design engineering and operational engineering.

Design engineering and the design pilots, yes, they ought to be very close together and talking to each other all the time when you are designing the vehicle.

Operations engineering, I am not so sure that it follows that necessarily the pilots and the engineers have to be even in the same town.

Dr. LITTLES. As a matter of fact, if you carried that to its logical inclusion, then all those engineers would be at the Cape, because that is where the hardware.

Senator HUTCHISON. I agree with you. I think that is the point, that the next step would be a different step, and I understand that, but I am talking design.

The other question I just wanted to ask is to Dr. Littles or to Dr. Mansfield. I think it would be to Dr. Littles, and that is: Do you ever envision a point at which we combine shuttle and station activities under a single prime contractor?

Dr. LITTLES. Yes. I envision that we will combine the operations aspects of shuttle and station. As a matter of fact, I had a team that was at JSC, formed two or 3 months ago, to look at that, to look at the potential combinations of functions between the space station program and the shuttle program, and aspects of payload

integration at the Cape, and the analytical integration of payloads into the hardware that is done at JSC.

That team has come back with a number of recommendations relative to efficiencies and improvements to consolidate some of that.

We have not yet moved to the point of consolidating the management structure. But I fully expect with time—and as a matter of fact, we have to consider that as we consider the restructuring of the shuttle. I fully expect that with time, we will have an operational program.

There will be an operations block, if you will, on the management chart, and that operations block will be both shuttle and space station at some point in the future.

Senator HUTCHISON. Yes, Dr. Logsdon?

Dr. LOGSDON. If you went back in history and dug out the testimony before the predecessor of this committee in 1970, you would find that there was one program called Station Shuttle.

The origins of the shuttle were as the vehicle for transporting crews and supplies up and down to a permanent outpost, to a station. That is what the shuttle was for in the first place.

So once the station becomes operational, and here we are talking seven or 8 years from now, to me, to manage shuttle and station operations as a system makes eminent sense.

But that is different than the design of station and development, which is what is going on at JSC now, and operating the shuttle on a routine basis, until, at the turn of the century the two meet as they were originally conceived to meet.

Senator HUTCHISON. That is far beyond, when you are really operating as a routine, hopefully.

Dr. LOGSDON. Well, I hope it is not so far. I mean we are finally, I think, on a positive trajectory, to build a station, instead of talk about it, to gain the experience in the shuttle-Mir program in Phase two of the station program with Russia, and then hook on the Japanese and European contributions to a truly international facility.

Seven years is just a little bit more than one Senate term. It is probably a time horizon that you can deal with rather well.

Senator HUTCHISON. Thank you.

Thank you, Mr. Chairman.

Senator BURNS. Thank you.

Dr. Grey, did you want to comment on the inspections that we are cutting back, and the review of how many steps we have from the AIAA?

Dr. GREY. Well, the AIAA has supported the independent review team's comments, and you will find in the report a number of suggestions for how to proceed without compromising safety. I am sure Dr. Littles and his crew are taking these to heart very carefully.

Senator BURNS. Right now we will leave the record open, and we will probably have some questions for you in writing, so that you can respond both to the individual senator and to the committee, and we will not close that record.

If there are other comments that you would like to make for the committee in that process, we would certainly welcome those comments.

Senator BURNS. We want to thank you for coming today. I am looking forward to my first trip to Johnson and Florida, and some other places, and visit with you, Dr. Littles, again, on a one on one.

I think if we just sat down and visited about our vision, where we want it to go and how we want to get it there, because I for one—even though I have very little NASA presence in the State of Montana, I am a big fan of what we are trying to do.

I think the American people still want to reach out to the unknown. I think when the American people quit doing that, then we become—we are not the society that we think America really is.

And I think we have the people, and the expertise, and the imagination to do that. I want to be a supporter of that. I do not want to be the problem. I would hope that we can be a facilitator on how we get that done.

Dr. LITTLES. Well, I appreciate that, and I stand ready anytime to support you in any way, talk to you, whatever.

Senator BURNS. Well, we certainly thank you for coming this morning.

These hearings are closed. Thank you.

(Whereupon, at 11:35 a.m,. the hearing was adjourned.)

APPENDIX

Questions Asked by Senator Pressler and Answers Thereto by Dr. Little

BUDGET

QUESTION 1: NASA is planning to cut $5 billion in five years from its budget. After inflation is taken into account, the cut is more like $8 billion. How will this pressure to cut the NASA budget affect the Space Shuttle program?

QUESTION 2: Since 1992, the Shuttle budget has been reduced from $4 billion to $3.1 billion. How can the program sustain further budget reductions?

Answers 1 & 2: We are committed to finding efficiencies, reducing infrastructure, restructuring and streamlining program activities which will reduce costs, however, the primary program goal of the Space Shuttle program is to fly the Shuttle safely. While we have yet to fully realize some of the potential savings from our recent cost reduction activities, I personally believe that we are approaching the limit with reductions that we presently contemplate. And I, in good faith, cannot agree to program budget reductions which jeopardize safety.

QUESTION 3: NASA s five-year plan calls for almost $800 million in unresolved reductions in NASA s Office of Human Space Flight, which manages both the Space Station and the Space Shuttle. Has NASA given any thought to how that reduction is to be divided between those two major programs?

Answer 3:

"The majority of funds to solve Human Space Flight's share of the President's Tax Cut reductions will be funded out of the Space Shuttle Program over a five year period. Major contributors which allow us to be somewhat confident the Shuttle can absorb such reductions and still fly safely are the deletions of some major content items. For example, the deletion of the Yellow Creek production of Redesigned Solid Rocket Motor nozzles in Iuka, Mississippi; deletion of the Lightweight Solid Rocket Booster upgrade as a performance enhancement; and elimination of funds for recompeting the external tank and solid rocket boosters in the outyears.

In addition, we have also taken major reductions in several areas. The Functional Workforce Review Team recommendations assisted in this process. The Kennedy Space Center launch operations and the Johnson Space Center mission operations workforce has been reduced as well as the Space Shuttle Program Office staff level. These reductions are allowed in part because of automated systems and facility upgrades being completed; negotiation of new contracts; and streamlining of requirements.

While the Space Shuttle Program is bearing the majority of the reductions, 1here remains a portion (roughly 50%) which we, today, do not know how to resolve. However, we still have review teams in place which have not completed their fact-finding; we still have a big integration job to do; and we have yet to restructure our organization and contracts to see those benefits. So while 50% is still a big challenge; as long as we are allowed the time it takes to transition—and do it right without impacting safety—the Office of Space Flight is committed to meeting the reductions.

QUESTION 4: The FY 1996 budget request for Space Shuttle is $3.2 billion, a three percent increase over the FY 1995 appropriation. Dr. Littles, what are the major activities supported in the budget request and what portion of those activities will go to improvements and upgrades for the current Shuttle orbiters?

Answer 4: Roughly 21 percent of the FY 1996 Space Shuttle Budget Request will go towards funding the Safety and Performance Upgrade portion of our budget. Major content items include safety upgrades on the engine program such as the Alternate Turbopump Program Development which will reduce failure modes (7 vs. 469 welds) and eliminate uninspectable areas. Also, the Large Throat Main Combustion Chamber is currently under development as a safety improvement to reduce the engine's operating temperatures and pressures. An example of a performance upgrade which will allow the Space Shuttle Program to better support Space Station Assembly is the Super Light Weight Tank Program. This development is incorporating new, lighter materials to achieve more performance to carry heavier payloads to the higher Space Station inclination. Other upgrade items include facility and system upgrades because of obsolescence and effort to support the upgrade developments.

SAFETY

QUESTION 5: Dr. Littles, your panel's internal study of the Shuttle program indicated the Shuttle's 35,000-person [workforce] could be reduced by 5900 people without compromising safety. Would you explain to the Subcommittee the methodology used to arrive at that figure? How would you determine which employees would be among the 5900 workers cut? Do you have any fear that you may end up cutting experienced technical people and managers and then end up having to hire them back?

QUESTION 6: Dr. Littles, in arriving at your estimate of the acceptable level of workforce reduction, did you elicit the views of the NASA personnel working on the Shuttle?

Answer 5 & 6: The Space Shuttle Program (SSP) Functional Workforce Review (FWR) was conducted between August 1994 and February 1995. The purpose of the review was to ascertain the minimum workforce required to support the SSP at Kennedy Space Center, Marshall Space Flight Center, Johnson Space Center, and Stennis Space Center. Twelve teams, independent of the Shuttle Projects, were assembled to perform a detailed review of contractor and civil service workforce. All civil service and most major contracts (contracts with more than 100 people) were reviewed. Some Projects were exempted either because they had just completed a bottoms-up review or because they were in the process of conducting contract renegotiations (these projects will be reviewed next year). Of the 35,000 current civil servant and contractor Shuttle workforce, this review looked at 26,910 personnel.

In conducting the reviews the teams were charged with the responsibility to insure recommendations were responsive to flying safe, meeting the manifest, and reducing costs, in that order. When recommendations were finalized by the teams, they staffed each recommendation with the affected organizations (civil service and contractor) to obtain and document reclamas. As a result of this process, some recommendations were changed. When NASA issued its Program Operating Plan 1995 budget guidelines, the Projects where asked to detail how they would meet the FWR dollar amount recommendations but were not tied to accepting specific FWR recommendations. This process or methodology insured feedback from Shuttle Project managers as well as insuring that reductions were taken in appropriate areas, as determined by front line managers.

To date we have only identified potential functional areas to downsize and have not identified a process to select which personnel to cut. When a process is identified to begin workforce reductions, factors such as skill mix will play heavily in the decision process and therefore we do not anticipate a situation where we would have to rehire personnel with key skills.

QUESTION 7: The Kraft panel, which conducted an external review of the Shuttle program, spoke of a safety heat shield whereby those opposing changes in Shuttle operations raise unfounded fears about Shuttle safety. What is the panel's view of that assessment?

Answer 7: Space Shuttle safety has been and always will be our number one concern. No action whether it be downsizing, streamlining or consolidating will be implemented without a thorough review for impacts on safety. We will not sacrifice safety for the sake of efficiencies.

PRIVATIZATION

QUESTION 8: Dr. Littles, I am very interested in proposals to privatize government functions that can be more cost-effectively performed by the private sector. It was interesting to see the Kraft panel, which was headed by the former director of the Johnson Space Center, come out in favor of Shuttle privatization. What is your assessment of the merits of privatizing the Shuttle? Would privatizing reduce Shuttle costs? How would a private company run the Shuttle program differently from NASA?

QUESTION 9: Dr. Littles, in a privatized Shuttle program, who would down the Shuttle and the related ground facilities? In the event of a Shuttle mishap causing personal injury and/or property damage who would be liable—the contractor or the government?

QUESTION 10: It is my understanding that many contractors believe the Shuttle would only be profitable for them if NASA commits to buying a certain level of launch services as a kind of "anchor tenant." If a significant level of government support or subsidy is required for a privatized Shuttle program to be successful, can it really be called a commercial activity?

QUESTION 11: How would the contractor managing the privatized program address the matter of Shuttle crew safety, an issue with which commercial providers of unmanned rocket services do not have to deal?

Answer 8-11: True privatization—turning the Space Shuttle program over to private industry—is an extremely complex issue requiring in-depth studies by both the NASA and private industry. The issues you raise—facilities, liability, actual cost savings, crew safety and possible government subsidies are issues that will be addressed if privatization becomes an eventuality.

The first step, however, toward privatization is the restructuring the Space Shuttle Program. I am sure that you are aware that several options are currently being considered. One option is the transition of Shuttle operations to a single prime contractor. The options focus on reviewing the Program requirements and management structure in light of the increasing maturity of Shuttle operations and the fact that most of the upgrades development will be completed by FY 1998. Options include elements of civil servant downsizing, safety and mission assurance reallocation, transition of operational responsibilities to the contractors and consolidation of activities with the Space Station Program. The transition timing from today's program structure to the new structure will be key to its success.

Any restructuring, streamlining or downsizing must be done carefully to avoid any safety risks. The challenges and changes in store for the Shuttle team will not be easy and they cannot be done overnight, but they must be done. We must consider these changes and challenges as an opportunity to make the Shuttle Program better, more efficient and more customer oriented.

Questions Asked by Senator Burns and Answers Thereto by Dr. Little

SPACE SHUTTLE

QUESTION 1: The five-year plan that NASA submitted with its FY 1996 budget request this year calls for the Human Space Flight Program (which funds the Shuttle and the Space Station) to drop from $5.5 billion in FY 1995 to $4.9 billion in FY 2000. About $800 million of the cuts over that period are characterized by unresolved reductions.

In reducing the funding for Human Space Flight, Dr. Littles, how will the reductions be allocated between the Shuttle and the Space Station?

Given the Space Station s history of cost overruns and schedule slippage, is it not likely that it will be difficult to find any savings in the Space Station program and that any reductions will be taken in the Space Shuttle Program?

Has NASA made any decisions on how it 'will deal with the $800 million in unresolved in its five-year budget plan?

Answer 1: The majority of funds to solve Human Space Flight's share of the President's Tax Cut reductions will be funded out of the Space Shuttle Program over a five year period. Major contributors which allow us to be somewhat confident the Shuttle can absorb such reductions and still fly safely are the deletions of some major content items. For example, the deletion of the Yellow Creek production of Redesigned Solid Rocket Motor nozzles in Iuka, Mississippi; deletion of the Lightweight Solid Rocket Booster upgrade as a performance enhancement; and elimination of funds for recompeting the external tank and solid rocket boosters in the outyears.

In addition, we have also taken major reductions in several areas. The Functional Workforce Review Team recommendations assisted in this process.

The Kennedy Space Center launch operations and the Johnson Space Center mission operations workforce has been reduced as well as the Space Shuttle Program Office staff level. These reductions are allowed in part because of automated systems and facility upgrades being completed; negotiation of new contracts; and streamlining of requirements.

While the Space Shuttle Program is bearing the majority of the reductions, there remains a portion (roughly 50%) which we, today, do not know yet how to resolve. However, we still have review teams in place which have not completed their fact-finding; we still have a big integration job to do; and we have yet to restructure our organization and contracts to see those benefits. So while 50% is still a big challenge; as long as we are allowed the time it takes to transition—and do it right without impacting safety—the Office of Space Flight is committed to meeting the reductions.

SHUTTLE SAFETY

Last year, NASA commissioned an internal study to determine the minimum workforce level necessary to fly seven-Shuttle flights per year. The February report (the "Littles Report ") on the results of that study concluded that the 35,000-person Shuttle workforce could be cut by 5900 people without compromising Shuttle safety.

QUESTION 2: Dr. Littles, do you believe that the Shuttle program can withstand personnel cuts of that size without increasing the safety risk to Shuttle crews?

Would these reductions be accomplished by buyouts or layoffs and how would they be allocated among the NASA field centers?

Answer 2: We do believe that the Shuttle workforce can be reduced by 5900 people taken over a period of time. The downsizing effort will be accomplished incrementally and by closely monitoring the impact on Program and people so that we can continue to assure safe flight and meet customer requirements.

The definitive implementation plans for conducting the workforce reductions and distributing the cuts among the Field Centers have not been completely developed. As the implementation plans are brought forward for approval senior Office of Space Flight management will scrutinize them to assure that their impact on individuals and the Shuttle Program in total are well documented and considered prior to any implementation.

QUESTION 3: The external study of the Shuttle program headed by former Johnson Space Center Chris Kraft (the Kraft Report) expressed concern about allowing defenders of the status quo in the shuttle program to hide behind the safety heat shield.

In your view, Dr. Littles, are the concerns raised about Shuttle safety legitimate issues or are they just an excuse to avoid considering needed reforms in the shuttle program?

Answer 3: Space Shuttle safety has been and always will be our number one concern. No action whether it be downsizing, streamlining or consolidating will be implemented without a thorough review for impacts on safety. We will not sacrifice safety for the sake of efficiencies.

QUESTION 4: Last year, it was reported that the resignations of two senior NASA officials, Robert Crippen (the former director of the Kennedy Space Center) and Jeremiah Pearson (the former head of the Shuttle program) were due in part to their fear that the pressure to cut budgets might compromise safety.

Dr. Littles, does it trouble you that there exists this perception that safety is being shortchanged in NASA s rush to save money in the Shuttle program and, if so, what can be done about it?

Answer 4: Safety is always a concern to everyone involved in the Shuttle program. The cost cutting exercises that we have been involved in for the past three years have not been at the expense of safety; and, in fact, they have been accompanied by a reduced number of in-flight anomalies, ground mishaps and quality problems. The hardware and operations have matured, even as the numbers of people required to safely run the program have come down. Again, we will not sacrifice safety for the sake of efficiencies.

QUESTION 5: The Kraft report recommends that a private contractor be given overall responsibility for operating and managing the Shuttle program, with NASA s role limited to general top-level oversight. Dr. Littles, what are the advantages and disadvantages of this approach and how would it significantly differ from the current manner of operating the Shuttle program? If one company is selected as the prime Shuttle contractor, what would happen to the other current Shuttle contractors? How soon could the one contractor proposal be implemented after the proposal is approved by the President and the Congress?

Answer 5: Several options are being formulated for restructuring the Space Shuttle Program. One option is the transition of Shuttle operations to a single prime contractor. The options focus on reviewing the Program requirements and management structure in light of the increasing maturity of Shuttle operations and the fact that most of the upgrades development will be completed by FY 1998. Options include elements of civil servant downsizing, safety and mission assurance reallocation, transition of operational responsibilities to the contractors and consolidation of activities with the Space Station Program. The transition timing from today's program structure to the new structure will be key to its success.

QUESTION 6: The Kraft Report also recommends that all Shuttle vehicle modifications be frozen except to cut costs, improve operations, make the Shuttle more reusable, or test new technologies. How is this recommendation different from current policy with regard to when Shuttle modifications are justified? If the Reusable Launch Vehicle Program is not approved by Congress and NASA is forced to rely on the Shuttle for the foreseeable future, would it still make sense not to fund Shuttle modifications and upgrades?

Answer 6: Space Shuttle vehicle design has been virtually frozen for the past several years except for the reasons you stated above. A decision will have to be made around in the year 2000 whether or not NASA will continue to use the Space shuttle for operations after the year 2005. At that time, the need for any modifications, upgrades, spares or replacement hardware will be reviewed and assessed.

QUESTION 7: The Kraft Report recommends that NASA undertake a top-to-bottom requirements review for the Shuttle, with the goal of reducing requirements based on our operations experience with the Shuttle program. When does NASA plan to conduct such a requirements review, what issues would it address, and how would it be conducted?

Answer 7: A program requirements review team was formed at the beginning of April 1995. The team is revising the Space Shuttle Program's philosophy by implementing the operational experience base for Program requirements. A change to the Master Verification Plan (MVP) has been approved that will emphasize in-flight checkout and incorporates the Program's operational experience to determine turnaround checkout requirements. The Program has also approved a change to update the criticality of hardware from a worst case design concept to an operational criticality that takes into account in-flight maintenance and Extra-Vehicular Activity (EVA) capabilities. This change in conjunction with the MVP change will significantly reduce checkout requirements. A scrub of orbiter checkout requirements to implement the operational experienced-based philosophy will begin in mid-July. Changes are being developed to the Shuttle Flight Rules and Launch Commit Criteria to implement the Program's operational experience base. Implementation of changes would begin in the July/August timeframe . The team is also reviewing the Program's requirements that determine the need for failure analysis of any discrepant hardware.

QUESTION 8: Dr. Littles, as part of NASA s zero-based review of the agency, there have been several intra-agency proposals to reallocate Shuttle-related duties and responsibilities among the NASA Centers. One internal NASA white paper recommends that management of the Space Shuttle program be moved from the Johnson Space Center if Houston to the Kennedy Space Center. It further suggests that all spacecraft engineering activities be closed at Johnson. However, Johnson would remain the lead center for human exploration and mission control activities. The white paper also calls for converting Kennedy into a government owned/contractor operated facility. Kennedy is now both owned and operated by the government.

What cost-efficiencies or other benefits are derived from moving Shuttle management from Johnson to Kennedy?

Would the experienced Johnson personnel, who have worked on the Shuttle for decades, be transferred to Kennedy, or would that knowledge base simply be lost?

Do you agree with the assessment of some former astronauts that it is important for the astronaut program to be located in the same place as the spacecraft they will fly?

Answer 8: Based on assessments made within the Office of Space Flight as well as recommendations by others, we have decided to restructure the Space Shuttle program to take advantage of the fact that some aspects of the program have become operational. In those areas, we will significantly reduce civil service involvement and provide more focused accountability and responsibility and reduced costs by consolidating our contract structure. In the process of restructuring, we will accommodate those elements of the program where development work is continuing and aspects of the program which will continue to require special attention and oversight.

Restructuring and streamlining of the NASA Shuttle program management structure will be in concert with the contractor restructuring and identified Center roles and missions from the Zero Base Review. Details on the implementation of the Shuttle restructure are still being formulated and assessed.

As for your specific questions the following guidelines will be followed:

- All spacecraft engineering activities will not be closed at JSC.
- MS FC/J SC design/development organizations will manage/accomplish vehicle modifications within their respective responsibilities and introduce block changes to the operational vehicle. Production activities will be migrated to the operational program at KSC.
- Mission flight planning and operations and crew training will be conducted at JSC.
- The Program Office (Level II) functions and management structure will be substantially streamlined. The office will have responsibility for budget, procurement, and overall program management and integration

Again, the details of the implementation plan are still in work and no final decision will be made until we are confident that our decisions will not jeopardize safety.

SHUTTLE PRIVATIZATION

QUESTION 9: Dr. Littles, the Kraft report recommends that the Shuttle program eventually transition to a privatized model where a private contractor would operate the Shuttle on a commercial basis, selling Shuttle launches to government and industry customers. How would a privatized Shuttle program differ from the current government run program?

QUESTION 10: Dr. Littles, would a privatized Shuttle program be any more efficient or productive than the current program?

QUESTION 11: Dr. Littles, over what time period could the transition to privatization be accomplished and what kinds of interim steps would be required to get to that point?

QUESTION 12: Dr. Littles, moving to a privatized system for the Shuttle raises a number of legal and policy questions that must be answered at some point. For example:

Who would own the Space Shuttle and the ground facilities, NASA or the contractor?

Assuming the contractor would take title to the Shuttle, the facilities, or both, would the company have to pay for them, and if so, how much?

In the event of a Shuttle launch failure causing loss of life or property, who would be liable—the government or the contractor?

To address public safety and health concerns, would NASA be required to continue some role in the Shuttle program, or could those matters be handled through regulation imposed on the contractor?

How much freedom should the Shuttle contractor be given in accepting different types of payloads and customers?

Should government missions be given priority over commercial payloads under a privatization policy?

Answer 9-12: Privatization of the Shuttle has been suggested. Not enough information is currently available to provide answers to your questions on privatization, however, as Space Shuttle Program restructuring options are formulated and assessed, the possibility of future privatization will be considered.

We consider that a first step toward privatization is the restructuring the Space Shuttle Program and as I mentioned previously, several options are currently being investigated. One option is the transition of Shuttle operations to a single prime contractor. This and other options focus on reviewing the Program requirements and management structure in light of the increasing maturity of Shuttle operations and the fact that most non-recurring upgrades development will be completed by FY 1998. Options include elements of civil servant downsizing, safety and mission assurance reallocation, transition of operational responsibilities to the contractors and consolidation of activities with the Space Station Program. The transition timing from today s program structure to the new structure will be key to its success.

Any restructuring, streamlining or downsizing must be done carefully to avoid any safety risks. The challenges and changes in store for the Shuttle team will not be easy and they cannot be done overnight, but they must be done. We must consider these changes and challenges as an opportunity to make the Shuttle Program better, more efficient and more customer oriented.

QUESTIONS ASKED BY SENATOR PRESSLER AND ANSWERS THERETO BY DR. JOHN MANSFIELD

REUSABLE LAUNCH VEHICLE (RLV) PROGRAM

QUESTION 1: The FY 1996 budget request asks for $159 million to start a new reusable launch vehicle program aimed at developing, and flight testing, the technologies needed to build a Shuttle replacement. Dr. Mansfield, how urgent is the need for a new launch vehicle or, put another way, how long can we afford to continue to rely on the current Space Shuttle?

Answer 1: The Reusable Launch Vehicle (RLV) program is not developing a new launch vehicle. It is a technology demonstration program aimed at enabling the commercial development and very low cost operation of the next generation reusable launch system. This is to be accomplished by reducing the business and technical risks between now and the end of the decade.

At the beginning of the next century, this country will be faced with the decision of whether to invest in upgrading current space launch vehicles or to allow for privately financed development and low cost operation of a next generation system, as a result of a modest investment in RLV technology demonstrations. The US is not commercially competitive with international space launch systems. Upgrades to cur-

rent launch systems will probably not change the international balance of launch competitiveness. Capitalizing upon the advanced technology the US has been developing over the past two decades, we can now move to a leap-frog improvement in launch capability that has the potential of permitting our industry to regain losses in world-wide commercial satellite launch market share, while providing sufficiently low launch costs to expand the market itself. NASA's integrated Shuttle/Reusable Launch Vehicle (RLV) approach ensures that it is poised to move forward on either of two scenarios in the year 2000: 1) completing the transition from the Shuttle to a replacement next-generation system by or before 2012, or 2) continuing to operate the Shuttle beyond 2012, with predictably large investments to improve operability. The investment in the next-generation system could largely be private (due to the reduction of risk resulting from the RLV technology program) with expansion of market share and market size, whereas investment in upgrades on existing systems will undoubtedly be funded by the US Government with little expectation of expansion of US market share and market size.

QUESTION 2: Currently, three contractor teams are developing competing designs for an X-33 experimental test vehicle. How is that process working and would you briefly discuss the differences between the three vehicle concepts being developed?

Answer 2: Three industry teams were chosen in March of this year to compete in a 15-month concept definition/design phase (Phase I). The teams are: Lockheed Martin (Palmdale, CA), McDonnell Douglas Aerospace (Huntington Beach, CA), Rockwell Space Systems Division (Downey, CA). This activity will be completed in June of 1996. The central requirement for these teams is to develop an X-33 demonstrator that will test the technologies aimed at an all rocket Single-Stage-to-Orbit (SSTO) RLV. These teams will be developing business plans required for a commercially developed and operated RLV, operations plans for the X-33 and RLV, and preliminary designs of the X-33 and RLV. Lockheed Martin is pursuing an integrated lifting-body/aerospike engine concept (vertical takeoff, horizontal landing). McDonnell Douglas is currently pursuing vertical takeoff, vertical landing. Rockwell is pursuing a wing-body vertical takeoff/horizontal landing concept. Specific payload capabilities, determined by market needs (commercial, military, and NASA), are being assessed by industry as a part of their business planning activities.

QUESTION 3: We are hopeful the X-33 competition will produce radical improvements in our launch vehicle systems rather than marginal improvements in current Shuttle technology. What features has NASA built into the selection process to ensure NASA does not take the conservative approach and pick the concept that is most like the Space Shuttle?

Answer 3: The X-33 is fundamentally different from any other program in that it demonstrates critical technologies for a radically new and internationally competitive launch vehicle that will revolutionize the space launch industry and enable for the first time real expansion in the utilization of space. These new technologies will permit a fully reusable, single airframe launch vehicle that goes into space and returns without staging elements along the way. For the first time in space launch history, we will not be in the 1950's ballistic missile technology mold. This mold has forced the space launch industry to maintain large manufacturing operations for expendable elements and large ground operations crews to assemble and check out these mullet-element launch vehicles each and every mission.

Another major difference is that the X-33 program is an industry-led, market-driven activity. NASA is not dictating the solution nor encouraging one concept over another. NASA laboratories are supporting industry at their request and are an integral part of the team—with industry clearly in the lead on concept selection. The goal is to enable the commercial development and very low cost operation of the next generation reusable launch system by reducing the business and technical risks between now and the end of the decade. Therefore, it is in NASA's best interest to allow the concepts to be market-driven.

QUESTION 4: By the end of next year, NASA plans to decide whether to proceed to the design, construction, and flight testing of an X-33 vehicle. What criteria will be used by NASA in arriving at a decision on the X-33?

Answer 4: Criteria have been developed between NASA, OMB, and OSTP which will guide the decision to proceed into Phase II. These criteria are both pragmatically and technically driven.

See the enclosed Decision Criteria for the Reusable Launch Vehicle Technology Program Phases II and III.

QUESTION 5: If approved next year, the X-33 would cost $650 million through the year 1999. Dr. Mansfield, was this $650 million cost assumed in the five-year budget plan submitted to Congress by NASA? Where would NASA find money to pay for this and, at the same time, cut $5 billion from its budget?

Answer 5: The submitted FY 1996 budget and out-year projections contain the Reusable Launch Vehicle program. As to finding the resources to support the RLV effort in a period of declining budgets, the NASA Administrator has answered this question on several occasions in various public and official venues. He has responded that with the exception of Space Shuttle safety there is no program underway at NASA that has a higher priority in the Agency.

QUESTION 6: It appears that pending Congressional budget proposals assume an even deeper cut for NASA than the $5 billion reduction proposed by the agency. What impact will that have on the affordability of the X-33 program?

Answer 6: As answered in the previous question, the impact of declining budgets has severe impacts on many NASA programs, but RLV is of sufficient importance and priority that reductions in this program will occur only at the point where Space Shuttle safety becomes an issue.

QUESTION 7: How important is NASA's X-34 program to develop a smaller reusable, or partially reusable, rocket for NASA? For what will the X-34 be used and what will be its commercial potential in the launch services market? Why is an "X"—vehicle being built that is to be a *commercial* launcher? And why, then is *NASA* helping to build a commercial vehicle? Finally, Dr. Mansfield, in addition to these problems, isn't the X-34 also redundant to the X-33 program and to the rest of what NASA is trying to do in its RLV program?

Answer 7: The X-34 is a key part of the RLV program and provides a critical step in the incremental development and demonstration of the enabling technologies required for an RLV. Demonstrating very low cost operations as well as technical feasibility is the focus of this effort. The X-34's goal is the development of a partially reusable small booster and relies on many of the same technologies of light weight structures, reusable cryogenic tanks, and highly operable vehicle systems as needed for a fully reusable large-scale single stage RLV. The X-34 fills the gap between the low altitude flight demonstrations of the DC-XA and the subsequent higher performance near orbital X-33 flight program. These programs are part of the phased incremental approach with each succeeding vehicle demonstrating greater performance (altitude & velocity) and larger scale integration of the required technologies. The X-34 being part of this phased approach, is not redundant, but rather complements the rest of the RLV program and enables a low risk approach to demonstrating the technologies for the eventual RLV full-scale development decision in the year 2000.

Lessons learned from each step of this program lowers the technical risks associated with the development of a cost-effective operational system. In addition to early demonstrations of the inherent technologies and the streamlined industry-led management approach of the RLV program, the X-34 program will also provide a flight test-bed for other related technologies, particularly in the hypersonic flight regime. The subsequent evolution of the X-34 into a cost-effective commercial launcher, capable of launching payloads of the 1000 to 2000 pound class is a logical adaptation and follow-on to the preceding experimental phase. This secondary goal does not lessen the quality or importance of the technology demonstrations for the RLV program, but rather capitalizes on the vehicle development as part of the technology transfer to industry.

QUESTION 8: NASA's Reusable Launch Vehicle program was intended to *complement* a parallel program at DoD to upgrade our fleet of expendable or throwaway rockets. However, last week, the Administration warned U.S. rocket builders that the new DoD rockets will have to *compete* with the RLV program for lightweight government payloads. NASA's existing "Med-Lite" rocket program also would seem to compete with DoD's rocket program. Dr. Mansfield, would you compare and contrast the NASA X-33 program, the NASA Med-Lite program, and DoD's expendable rocket program? Do you find any overlaps and duplication among these programs?

Answer 8: National Space Policy established last year directed that DoD develop improvements in the expendable launch vehicle arena and that NASA develop technology to support a later decision to be made concerning single-stage-to-orbit viability. There are some synergistic opportunities that may be logical to pursue between these two programs, and both agencies have agreed to identify such opportunities and cooperate where it makes sense to do so.

The notion that expendable launchers will have to compete with reusable vehicles some day in the future is undoubtedly true. It is also true that the very fact that a system is reusable and economically operable should motivate all customers of such systems, including government users, to purchase these services from the lowest priced providers. It is not true that the RLV program being executed is in competition with DoD efforts. It is my understanding that DoD improvements to expendable launchers will be available, at least on mid-range payloads, before the end of the decade decision concerning next generation, reusable launch systems. In con-

trast to the EELV and the RLV development programs, the "Med-Lite" activity looks to a fixed-price purchase of launch services for NASA payloads in a payload weight category not addressed by current launch service contracts. As is the Agency's practice, the Med-Lite Request for Procurement (RFP) was a performance based RFP that left to the private sector whether to propose an existing, upgraded or newly developed system. The Agency is in final negotiations and hopes to sign the Med-Lite contract within a few weeks.

At the same time that NASA and DoD are seeking synergistic opportunities on which to cooperate, we are also looking for areas of possible duplication. It is likely that they are the same thing in that duplication and overlap imply a technical requirement resident in both programs.

Questions asked by Senator Burns and Answers Thereto by Dr. John Mansfield

Reusable Launch Vehicle (RLV) Program

Budget

QUESTION 1: At a time when NASA is trying to cut $5 billion over the next five years, continue huge projects like the Space Station, and start two new astronomy projects, what prompted NASA to propose a new launch vehicle program for FY 1996 and can NASA afford it?

In the near term, is it more cost-effective to simply maintain and upgrade the Shuttle?

I understand that the construction of any test vehicle might require industry cost-sharing. How much money do you believe that industry would willing to spend on a new vehicle, and, what conditions would industry insist on?

Answer 1: At the beginning of the next century, this country will be faced with the decision of whether to invest in upgrading current space launch vehicles or to allow for privately financed development and low cost operation of a next-generation system, as a result of a modest investment in Reusable Launch Vehicle (RLV) technology demonstrations. The US is not commercially competitive with international space launch systems. Upgrades to current launch systems cannot change the international balance of launch competitiveness. Capitalizing upon the advanced technology the US has been developing over the past two decades, we can move to a leap-frog improvement in launch capability. This has the potential of enabling our industry to regain world-wide commercial launch market share, while providing sufficiently low launch costs to expand the market itself. NASA's integrated Shuttle/RLV approach ensures that it is poised to move forward on either of two scenarios in the year 2000: 1) completing the transition from the Shuttle to a replacement next-generation system by or before 2012, or 2) continuing to operate the Shuttle beyond 2012. The investment in the next-generation system could largely be private (due to the RLV technology program) with expansion of market share and market size, whereas investment in upgrades on existing systems will undoubtedly be funded by the US Government with little expectation of expansion of US market share and market size.

On average, industry is currently sharing 50 percent of the cost of current X-33 activities (design and technology demonstration). For the final design/build/flight test of the X-33, industry is currently exploring several options for cost sharing.

Investing in X-33 will likely be borne largely by the Government, thereby requiring a relatively small industry percentage investment (less than currently involved). Hence, no substantive conditions are likely to be required during this phase to enable an industry/government partnership. However, since the selection of the industry team(s) for the experimental phase requires a business plan for the experimental (1996–1999) and the operational phase (beyond the year 2000), governmental actions that may enable a privately financed operational phase will likely be explored during the next year.

QUESTION 2: As you know, NASA and DoD have funded several unsuccessful programs to develop new vehicles under names like "Advanced Launch System," "New Launch System," and "Spacelifter." None of these programs produced a new rocket for the nation, yet billions were spent on these efforts. Do you have any reason to believe that the RLV program will be more successful that the earlier failed efforts? What lessons did the government learn from those other programs that would help NASA successfully manage this new RLV program?

Answer 2: This program is engaging industry in a partnership relationship that involves cost sharing. Government technical R&D support is supplied when requested by the industry, rather than the traditional oversight. That relationship,

now in place for over one year, is proving to be efficient and productive. This program is stressing hardware development, rather than paper studies, and demonstration of operations based technology that proves systems necessary to attain low cost operations. Finally, business planning by industry and the private investment community will be a major factor in the decision leading to the next-generation system.

NASA believes that achieving truly low cost access to space, requires the next-generation launch system to be market-driven and industry-led. NASA laboratories are supporting industry at their request in area's of NASA expertise and are an integral part of the team—with industry clearly in the lead.

QUESTION 3: What capabilities is NASA looking to design into the X-33 test vehicle? Is Single-Stage-To-Orbit (SSTO) capability a requirement or a preference in the X-33 design? Given the trend towards privatizing Shuttle functions, will industry-driven requirements for the X-33 have priority over NASA mission requirements?

Answer 3: The X-33 is fundamentally different from any other program in that it is an industry-led, market-driven activity. NASA is not dictating the solution nor encouraging one concept over another. The goal is to enable commercial development and very low cost operation of the next-generation reusable launch system. The X-33 program is contributing toward achieving this goal through a vigorous technology demonstration effort between now and the end of the decade that reduces business and technical risks. It is in NASA's best interest to allow the X-33 concepts to be market-driven. Specific payload capabilities, determined by market needs (commercial, military, and NASA), are being assessed by industry as a part of their business planning activities.

QUESTION 4: What is the intended role and mission of the proposed X-34 program to build a test vehicle? How does the content and purpose of the X-34 program differ from the X-33 program?

Answer 4: The goal of the RLV program is to reduce dramatically the cost of access to space. The Access to Space Study, completed in January 1994, concluded that Single-Stage-To-Orbit (SSTO) offered the most promise of dramatic cost reductions. The X-33 program is intended to try to prove the validity of this conclusion by demonstrating, in flight and ground tests, the technologies needed to prove the feasibility of the concept of an all-rocket SSTO RLV. The demonstration will focus on very low cost operations, as well as on technical feasibility. In order to accomplish this, the X-33 must fly higher (potentially near-orbital) and faster (approximately Mach 18) than the X-34. The next- generation RLV (and hence the X-33) will require high performance, hydrogen based main engines—the X-34 will not utilize such an engine system. The larger scale of the X-33 (approximately 50 to 75 percent of the RLV) is required to demonstrate the mass fraction, robustness and low cost operations feasibility of SSTO. The X-33 must prove that such an advanced system can result in very low cost operations while using RLV class systems.

QUESTION 5: Is it my understanding that the management and procurement practices in the X-34 program are intended to be extremely efficient and streamlined relative to NASA's normal practices, and also to serve as a model for how the X-34 and other programs are handled in the future. How has the X-34 program been different from other NASA development projects in terms of management and procurement? How many civil service personnel at NASA are assigned to the oversight of the X-34?

Answer 5: The X-34 program differs from previous programs in several areas, mostly centered around the concept of an industry-led partnership, rather than the traditional customer-contractor relationship. The NASA project office has been streamlined with only three people managing of the project: the project manager, a combined position of deputy manager and chief engineer, and a lead business analyst. The project manager reports directly to the Space Transportation Division Director at NASA Headquarters resulting in only two layers of management below the Associate Administrator level as compared to four for the typical Shuttle project office. Furthermore, the NASA project manager has been co-located to the industry partner's facility and assigned as a deputy to the industry project manager as part of the industry-led partnership arrangement.

The RLV program is being led by approximately 12 field center personnel and 8 NASA Headquarters personnel. The majority of the NASA participation is in a subcontracting role to the industry partner, with well defined and documented deliverable products and schedules, rather than in the traditional oversight role.

The X-34 project has been structured as a fast track program with the first orbital flight, using an expendable second stage for payload insertion, scheduled approximately three years into the program. The fast track approach started with the procurement process which occurred over an 80-day period, with 45 days for proposal solicitation, and 35 days for source selection and negotiation.

QUESTION 6: NASA is planning to use DoD's DC-X experimental vehicle in the RLV program. The DC-X, also know as the Delta Clipper—Experimental, is a subscale reusable rocket that has been successfully flown by DoD several times. What are NASA's plans to use the DC-X in its RLV program? What were the reasons why DoD did not build on the DC-X activities to develop a new launch system?

Answer 6: The NASA RLV program, like DoD's DC-X project, is structured to demonstrate the feasibility of a rocket-powered Single-Stage-to-Orbit (SSTO) launch vehicle. The DC-X concept (vertical lift-off, vertical lander) represents one of three potential configurations of the eventual RLV. During the competitive phase of the RLV program, the DC-X, and later the DC-XA, will demonstrate both DC-X specific as well as generic RLV technologies. After the DC-X flight series, the vehicle will be upgraded with more advanced technologies as part of the phased incremental approach of this program, and reflown as the DC-XA. These upgrades, which include lightweight reusable cryogenic tanks, composite primary structures, and advanced propulsion subsystems, will demonstrate technologies applicable to all three RLV concepts. During Phase II of the program, after the configuration downselect, the DC-XA may or may not be utilized further, depending on the proposed plans of the selected industry partner(s).

NASA with DoD participation did in fact build on the DC-X activities as part of the RLV program as described above. The DoD did not proceed with the DC-X as a DoD program on their own due to the NASA Implementation Plan for the National Space Transportation Policy which directed that DoD pursue upgrades of the expendable launch vehicle fleet and support NASA on the RLV program.

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